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INTERNATIONAL ELECTRICAL STANDARDIZATION.

At the recent electrical congress held during the Louisiana Purchase Exposition, St. Louis, 1904, there were two distinct bodies—the congress, an unofficial body composed of all who desired to join it; and another body, the senate, made up of delegates from a number of governments. One of the important actions taken by the latter body was the resolution passed unanimously that it be recommended by the delegates to their several governments that an international commission be formed which should study the problem of bringing about uniform practice in electrical matters. So far as the science is concerned, electrical units are international, but it was thought that great good could be accomplished if simpler methods of rating and testing electrical apparatus should be adopted. This recommendation has been adopted by the governments interested in the matter, and as a result a preliminary meeting was held in London during the latter part of June. The delegates met at the Hotel Cecil on June 26, and Mr. Alexander Siemens occupied the chair. The main business was to organize and formulate the rules which should govern the commission. A draught of rules had already been prepared for the commission by a committee of the Institution of Electrical Engineers, of Great Britain, and these were taken up on the day of the meeting and the following day, when, after some important amendments, they were adopted. These rules can not be made public until they have been submitted to the various governments concerned. Since, however, they have been carefully considered and accepted by the delegates, it is very probable that they will be satisfactory. It is said, however, that much care has been taken to prevent government interference with the work of the commission. The election of Lord Kelvin as first president of the commission will be hailed with gratification and pleasure throughout the world. It is a well-deserved recognition of his invaluable services both to science and industry, for there is no one to whom the electrical world is more indebted than to Lord Kelvin.

Now that these steps have been taken to secure coordination in the work of standardization, the question of how far such standardization should go becomes exceedingly important. There is no doubt that various national organizations of the countries whose governments are cooperating through this commission will bring their individual rules into agreement with those of the international body. In fact, it seems safe to assume that these governments will be largely guided by the recommendations of their local bodies and will select, as has been done already, their delegates from such organizations. The problem therefore narrows itself now to bringing about agreement among the electrical societies. Such rules as are adopted are likely, for this reason, to be conservative, and their extension will be slow. It is probable that this is a good feature, for it is better in such matters to go a little too slowly than a little too fast. An ill-advised rule is apt to injure and retard the industry, and to have a wider effect than a good one.

It will be remembered that at the recent convention of the American Institute of Electrical Engineers, at Milwaukee, this question of standardization was brought up by the presentation of a report by the Institute committee and during the discussion a good deal of disagreement was expressed, some members holding that the committee had gone entirely too far; others that parts of the rules were bad. The report was accepted, however, with the understanding that the rules were not

final, but were merely offered as suggestions, and that the whole subject would be gone over most thoroughly before they were brought up again for final adoption. If there is any doubt about the length to which it is desirable for our own committee to proceed in this work of standardization we may expect considerable divergence of opinion regarding the international rules. It will therefore be interesting to await the publication of the international committee's rules, to see whether they purpose merely laying down broad lines for the guidance of engineers and manufacturers, or if they intend specifying more definitely methods of testing, the performance of electrical apparatus and other matters of detail. If the former plan is the one proposed not much difficulty need be expected in obtaining an agreement, but should the commission have the latter idea in view its work will be slow and subject to much discussion and criticism.

A RIVAL OF ELECTRICAL TRANSMISSION.

Probably nine persons out of ten if asked what is the best way of transmitting power will say, "by means of electricity," and the tenth person will also give the same reply, unless he happens to be a gas engineer. Until very recently the problem of transmitting power in large quantities over great distances was considered almost purely electrical, and although text-books on power transmission and generation touched upon the possibilities of other means, such as compressed air and gas, these did not receive very much attention. Recently, however, power transmission by means of gas has been under discussion, particularly in England, where the local conditions at London may possibly have had something to do with the respectful consideration the proposal has received. It should be pointed out that these plans do not contemplate abolishing the electric motor. The gas is to be used for transmission only, and not for distribution, for in the latter use the motor is unrivalled. In fact, this fact is recognized by the gas engineers themselves, as is shown by the following quotation from Mr. C. A. Smith, when urging, in the *Electrical Times* (London) for June 21, power transmission by means of gas: "Of recent years a good deal has been said about generating electricity at the pit's mouth and transmitting it to various industrial centres, but it will be considerably cheaper to manufacture producer gas at the pit's mouth and transmit it through pipes to the industrial centres, there to use it in driving gas engines for generating electricity, and also for heating and furnace work. The question of distribution and transmission of power must not be confused. For the former it is agreed that there is no agent to compare with electricity; for the latter purpose it is suggested that it is more economical to employ producer gas and piping than electricity and cables." The emphasis is laid here upon the transmission of the cheapest form of gas, which is not only to bring cheap power to the city, but to do away with smoke.

This same problem is gone into with a little more detail by Mr. H. A. Martin in a paper before the Society of Arts, London, an abstract of which will be found on another page of this issue. Mr. Martin looks at the economical side of the problem, and proposes the use of gas because it will conserve the British coal supplies and prevent smoke. He gives figures showing that this can be done and the gas sold for about twenty-five cents per thousand cubic feet, and still bring a profit. Mr. Martin also dwells upon the transmission part of the work, presumably leaving the distribution of power to local electrical generating plants.

Mr. Martin's plans seem rather complicated. The system itself is simple: the gas is to be generated at the mines and transmitted under high pressure—about 500 pounds per square inch—to the power centres, where it will be used for heating and in internal-combustion engines. But to do this requires not only a producer plant at the mine, but a large compressor plant, otherwise the cost of pipes would swamp the undertaking. But this high pressure calls again for reducing-pressure plants at the receiving station, and it is proposed here to utilize the remaining gas pressure—which will be about half the initial—directly in expansion engines, which, in turn, drive dynamos to furnish electric power for lighting and other purposes. In other words, the gas transmission system, as well as the high-tension electrical system, requires a step-up-transformer station and a substation at which the pressure of transmission may be lowered to that at which it is to be utilized. Stress is also laid upon the by-products of the gas system—the production of fertilizer and the utilization of the cooling action of the expanding gas in refrigerating plants. The question seems at first sight to narrow itself down merely to a transmission problem, and this is the way in which it has been viewed in the two papers referred to above. But there are other considerations: the conversion from gas transmission to electrical distribution would probably not be as simple as has been assumed. The economic generation and distribution of electricity requires a fairly large power-house supplying a large district, and such a system must utilize a high potential and be equipped with substations. Moreover, it is probable that smoke legislation will, in the future, deal not merely with the production of soot, but with the setting free of large volumes of burned gases. It is likely therefore that the power stations will be located on the outskirts of a town, and will, for this reason, employ substations scattered throughout the various sections of the district supplied. It is such a system, using transmitted gas, which must be compared with an electrical system with a large generating station at the mine, and a number of substations in the city. Transmission by gas will not eliminate any part of the electrical system except the transmission lines, and hence, when figuring the cost of power transmitted electrically, the cost and the losses of the substations must not be considered.

Transmission by gas, it is true, will solve some of the problems not solved up to the present time by electrical transmission. While all admit that no small motive power can compare with the electric motor, and that electric lamps are the best illuminating agents yet devised, when it comes to heating, the electrical system is at a disadvantage. Electrical heaters are per-

fectly efficient—that is to say, all the energy supplied to them is converted into heat, but the losses which have taken place before the energy reaches the heater are very great, while in the gas system all of the energy of the gas is converted into heat, though all may not be utilized. In other words, we start with our energy in the form of heat, which is obtained by burning the gas. In the electric system we must carry this through a number of transformations, one of which is not very efficient. This disadvantage applies only to electric energy generated from fuel. When obtained from other sources the transformation ratio is high, and the cost depends mainly on the cost of the apparatus.

Since the introduction of electrical power into industrial and commercial life there has been a marvelous development. Methods of communication have been vastly increased; the efficiency of the worker and the electric motor is revolutionizing our methods of applying mechanical power either for transportation or manufacture. It is becoming such an important agent that all water powers have taken on a new significance and are rapidly becoming one of the most coveted of a state's resources. The utilization of these powers has been by electrical means, and while we have divided this process into parts—generation, transmission and distribution—we have considered these divisions rather from the standpoint of convenience. In this work we have had no rivals, but now the gas man would have us believe that when it comes to transmitting power obtained from fuel that all of our work has been vain and that we must fall back upon other methods. The proposal is interesting, and it will be carefully analyzed; but until further evidence is produced the nine out of ten will still retain their original opinion.

THE ELECTRICAL MANUFACTURE OF NITRITES.

At the annual meeting of the German Bunsen Society, which was held at Dresden during May last, the report of which appears on another page of this issue, a most satisfactory discussion took place upon the manufacture, by means of the electric discharge, of compounds of nitrogen and oxygen. This is a subject which has been referred to frequently during the past five years, and upon which a number of papers have been read. Generally, however, such discussions have considered merely one phase of the problem, or have dealt with but one proposed solution. At the Bunsen meeting, to the contrary, various phases of this matter were considered. It was attacked from the chemical side with a lecture upon the physical properties of nitrogen, delivered by Professor F. Foerster, of Dresden. The physico-chemical side was presented by Dr. W. Nernst, of Berlin, who read a paper upon "The Equilibrium and Reaction Velocity Ratios of Nitric Oxide Formation." A second paper by Professor Foerster described the Birkeland and Eyde system, which is now in actual operation in Norway. Professor M. Le Blanc, of Karlsruhe, discussed "The Estimation of Nitric Oxide in Air;" Professor J. Klaudy, of Vienna, the technical methods for converting the nitrous gases into nitric acid and its salts; and Professor Adolf Frank, of Charlottenburg, in the last paper of this series discussed the fixation of atmospheric nitrogen by means of calcium carbide. This list of papers, as well as the names of their authors, show how thoroughly the matter was threshed over.

It seems that the chemistry of the process has been neglected, as have also the thermal relations, but these two phases were well treated in the two papers by Nernst and Le Blanc. The latter showed that the methods generally employed in estimating the nitric oxide are inaccurate, as there are a number of conditions which influence these determinations greatly.

The discussion by Nernst was particularly valuable. As is well known, the formation of nitric oxide is an endothermic reaction, as energy must be supplied to the two gases before they will combine; but if the product of the reaction be heated somewhat higher, it will decompose again. Hence it is necessary to remove the products of the reaction from the ozone in which the combination takes place quickly. A rapid circulation of air through the furnace would seem desirable for this reason, but a rapid movement of the air will give a product dilute in nitric oxide. It is therefore highly essential that the rate at which air is forced through the furnace should be determined. This rate, of course, depends upon a number of things—on the time during which the air is exposed to the action of the flame, and upon the temperature within the furnace. It is this important part of the problem that was dealt with by Nernst. He obtained an equation enabling him to calculate the speed at which the reaction takes place, from which it is possible to compute the time required and any given temperature to reach a given saturation of nitrous oxide. His computed concentrations agree well with those found experimentally.

The discussion of the technical methods for carrying out this reaction indicates that the Birkeland and Eyde process is in successful commercial operation. This, it seems, is the only one of the many processes which has survived the test of actual operation. The process, it will be remembered, is that in which a wide electric arc is produced by drawing an alternating arc between the poles of a powerful electromagnet. The air to be treated is passed through the furnace in which this flame is maintained. According to Foerster, this furnace takes 500 kilowatts, ten per cent of which is used in producing the magnetic field. Through this furnace twenty-five cubic metres of air are passed per minute, giving a concentration of two per cent of nitric oxide. Expressed in another way, the furnace produces from seventy to eighty grammes of nitric acid per kilowatt-hour, equivalent to from 1,100 to 1,300 pounds per kilowatt-year. The cost of power is put at a little less than 0.15 cent per kilowatt-hour, corresponding to 3.1 cents per pound of nitrogen in the form of nitric acid. The same amount of nitrogen in the form of Chili saltpetre costs, in Europe, over four times as much. The first figure, it must be remembered, takes in only the cost of power and considers nothing in regard to the cost of operating the plant. It was pointed out that during last year 1,500,000 tons of nitrate of soda were used, to produce which by the electrical method just described would require about 2,500,000 horse-power. One-third of this material was consumed by Germany alone, where, it is said, there are waste gases from blast furnaces now in operation which would produce 500,000 horse-power, which might be used to supply part, at least, of Germany's demand.

THE ANNUAL CONVENTION OF THE NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION.

CLEVELAND, OHIO, JULY 18, 19 AND 20.

Special Telegram to the Electrical Review.

CLEVELAND, OHIO, JULY 18.—The sixth annual convention of the National Electrical Contractors' Association was held in Cleveland, Ohio, July 18, 19 and 20. All of the members of the several committees arrived in Cleveland for conferences on Monday, July 16, and on Monday morning a meeting of the board of the national association was held. On Monday afternoon the Electrical Contractors' Association of Ohio held its annual meeting, this being a formal meeting, as its interests were merged with the national association's meeting.

About 450 men, representing the electrical contracting industries of the country, and a number of representatives of manufacturing companies and supply houses were present when the convention of the National Electrical Contractors' Association was called to order by A. Oppenheimer at 10.30 o'clock Wednesday morning. The first session was an open meeting, though the later meetings were participated in only by members of the association. An exception to this rule was the session on the third morning, to which all the visitors and attendants were invited.

At the opening meeting Chairman Oppenheimer introduced the Hon. Tom L. Johnson, mayor of Cleveland, whose witty and brilliant remarks elicited a great deal of enthusiasm. Other addresses were made by W. B. McAllister, president of the Builders' Exchange; F. M. Lawton, state director for Ohio, and a very graceful response was made by President James R. Strong. Frank E. Patterson, of New York city, then read a paper entitled "Engineering Problems." The opening session was attended by a number of ladies.

Among those in attendance were the following gentlemen, many of whom are well known in manufacturing and commercial lines: V. C. Gilpin, R. G. Kennedy, L. H. Keller, O. C. Turgeon, Robert Garland, H. C. Adams, H. B. Kirkland, E. J. Kulas, M. C. Morris, J. M. Fullman, Bailey Whipple, C. R. Sloan, Thomas T. Richards, Thomas G. Grier, F. M. Harrington, I. A. Bennett, E. R. Dull, P. H. Hoven, R. L. J. Fortune, A. O. Einstein, Francis Raymond, F. Trumbel, David Aiken, C. H. Haddiel, C. M. Crofut, F. F. Skell, George F. Searing, W. P. Crockett, J. B. Olson, Charles Auth, Warren Ripple, O. R. Woodock, E. W. Rockafeller, B. F. Bechtel, H. M. Gail, Charles W. Webb, M. F. King, W. Brewster Hall, Thomas J. Ryan, D. J. B. Baldwin, W. S. Greene, H. D. Betts, E. S. Ford, D. L. Markle, R. B. Bragins, F. M. Swan, William Ennis, L. P. Sawyer, W. Dusenberry, William Mill, John W. Brooks, A. W. Little, F. W. Bliss, C. E. Corrigan, W. J. Barr, W. E. Phelps, Thomas E. Barr, R. A. Schoenberg, C. O. Baker, Alex Henderson, Alpha H. Kling and W. G. Tingley. S. H. G.

The Meeting of the American Association for the Advancement of Science.

The fifty-sixth meeting of the American Association for the Advancement of Science was held at Ithaca, N. Y., June 28 to July 3. This was an extra summer meeting, the winter meeting at New Orleans, La., having been held six months previous, and the next winter meeting being planned for New York six months later. In consequence there were no presidential addresses and no election of officers, except to fill vacancies, and but little action of any kind was taken by the council.

The societies in session were as follows: American Physical Society, American Chemical Society and the New York chapter of the Society for Chemical Industry, Society for the Promotion of Engineering Education and the American Microscopical Society. Sessions were held by Section B, Section D, Section E and Sections F and G.

Cornell University placed its buildings at the disposal of the association, and each day furnished a mid-day lunch to the members. An informal smoker was held on the evening of Thursday, June 28, at the Town and Gown Club. The formal opening and dedication of Rockefeller Hall, the new physical laboratory of Cornell University, on the afternoon of Friday, June 29, included addresses by President Schurman, Professor E. L. Nichols, Dr. Elihu Thomson, Dr. W. H. Welch, and a letter from Professor W. A. Anthony read by Professor E. Merritt.

On Saturday evening, June 30, an address was presented by Professor Henry S. Carhart, of the University of Michigan, on "The South African Meeting of the British Association for the Advancement of Science," illustrated by a series of lantern slides.

On the afternoon of Monday, July 2, a reception was given at the residence of Dr. and Mrs. Andrew D. White.

International Association of Municipal Electricians.

The eleventh annual convention of the International Association of Municipal Electricians will be held at New Haven, Ct., August 15, 16 and 17. An excellent programme of papers has been arranged, the following having been promised:

"History of the Fire and Police Telegraph," by Adam Bosch, Newark, N. J.

"Details of Certain Auxiliaries to Fire-Alarm Apparatus," by J. B. Yeakle, Baltimore, Md.

"Advisability of Protecting Municipal Electricians by the Civil Service Laws," by Jerry Murphy, Cleveland, Ohio.

"Comparison of Underground and Overhead Wiring, and of the Relative Values of Single Rubber-Covered Wire and Lead-Encased Cable for Underground Construction," by W. H. Thompson, Richmond, Va.

"Conditions Surrounding the Inspection of Wires in the Southwest," by Clarence R. George, Houston, Texas.

There will also be a question box, which has been compiled by W. M. Petty, Rutherford, N. J.

Bust of Volta Presented to the Institution of Electrical Engineers, of Great Britain.

On Monday, June 25, the electrical engineers who were visiting England were entertained by the Institution of Electrical Engineers at the Hotel Cecil, London. There were about 500 persons present, among them being Mr. J. Gavey, president of the institution; Lord Kelvin, and Sir Joseph Swan. A feature of the reception was the presentation to the institution of a bronze bust of Allessandro Volta by the Associazione Elettrotecnica Italiana. The presentation was made through Mr. E. Jona, president of the associazione. A number of prominent electrical engineers took part in the speech-making, among them being Mr. Gavey, Professor J. L. Farney, representing the Association Suisse des Électriciens; Mr. E. Hospitalier, past-president of the Société Internationale des Électriciens; Dr. E. Budde, president of the Verband Deutscher Elektrotechniker; Dr. Emil Naglo, representing the Elektrotechnicher Verein; Dr. S. S. Wheeler, president of the American Institute of Electrical Engineers, and Mr. Guido Semenza, honorary general secretary of the Associazione Elettrotechnica Italiana.

New York Telephone Company's Bid to the City.

The New York Telephone Company has partly accepted and partly refused the terms proposed by New York city as the basis of an arrangement for the continued operation of its system in the city without competition. The company has made answer in a letter sent to the Board of Estimate, replying to a resolution passed by that board on June 15, which was practically to the effect that if the company did not ask for a franchise which would carry with it the payment of a percentage of its yearly revenues to the city, and would not confess judgment in the matter of $6,000,000 rental claims which the city has brought against the Empire City Subway Company, the board would proceed to consider the advisability of granting a franchise to the Atlantic Telephone Company to put in operation a competitive telephone system. The letter is signed by Charles F. Cutler, president of the New York Telephone Company, and U. N. Bethell, president of the New York & New Jersey Telephone Company. In effect, the company offers the city the payment of $3,500,000, to be paid in twenty-five years, and $200,000 a year thereafter. It will make still further reductions in its rates for service, and it will make a fifty-per-cent reduction in its charges for municipal telephone service.

The company will not surrender its franchise rights, as it believes that it would be impossible to continue a sound development of its system, and would be impossible to make further reductions in rates unless the company was in a position in the future to deal freely with the constantly changing conditions.

The total compensation offered by the Atlantic Telephone Company for a twenty-five-year franchise amounts to $2,680,000 for the twenty-five years, while the total compensation offered by the New York Telephone Company for the same period is $3,500,000. The Atlantic company has offered an additional $100,000, to be paid within thirty days after the granting of the franchise. The Bureau of Franchises has suggested an initial cash payment of $250,000. If this sum should be agreed upon the total payments of the Atlantic Telephone Company would be brought up to $2,930,000.

The company announces that it is impossible for it to confess judgment involving a forfeiture of its subways, and it will consent to do everything possible to expedite the trial of the action, or that if it should be deemed desirable it will consent to the settlement of the question by arbitration.

The Efficiency of Steam Plant.

Two papers upon this important subject were read and discussed in London on Friday, June 22, at the eleventh annual gathering of that very exclusive and select body known as the Incorporated Municipal Electrical Association. Abstracts of the more important portions of the two papers will appear in a later issue.

The first of these papers dealt with the use of live steam for heating the feed-water of boilers, and was contributed by George Wilkinson, chief electrical engineer of Harrogate. The live steam feed-heating apparatus used in these experimental trials was constructed by Messrs. Dales and Braithwaite, of London, and is based upon the principle of spraying the feed-water into a chamber which is connected with the steam portion of the boiler. This system of preheating differs from the much-discussed thermal storage system of Drewitt Halpin in that all the feed-water used in the boiler is passed first through the economizer and then through the live steam feed heater, and is thus raised nearly to the steam temperature before it enters the boiler. Mr. Wilkinson has failed to state, however, that this system of working is no new proposal, the raising of all the feed-water to the steam temperature having been recommended by Mr. Hamilton and also by Messrs. Booth and Kershaw, in their much-discussed Institution paper read in London on January 26, 1905. The experiments made at Harrogate by Mr. Wilkinson were carried out with an ordinary type Lancashire boiler, provided with a Green type of economizer of 288 pipes. The economizer alone raised the feed to a temperature ranging from 213 degrees Fahrenheit to 265 degrees Fahrenheit. The Dales and Braithwaite apparatus added from eighty-three degrees Fahrenheit to 120 degrees Fahrenheit to this temperature, and the feed-water in these experiments could thus be raised to a temperature ranging from 333 degrees Fahrenheit to 348 degrees Fahrenheit. The temperature of the steam during these tests of the live steam feed heater was between 353 degrees Fahrenheit and 360 degrees Fahrenheit. Six steam-raising tests were made during the trials of this system at Harrogate—one with cold-water feed, two with economizer feed and three with both the economizer and the live steam heater in operation. The results showed a gain of 12.7 per cent in the combined efficiency of the plant, when the live steam heater was in operation and the consumption of coal was at the rate of 27.31 pounds and 29.53 pounds per square foot of grate area per hour; while at the lower rate of fuel consumption the gain by the use of the live steam feed heater was 7.0 per cent. If the tests carried out by Mr. Wilkinson are correct (there appears no reason for doubting their accuracy), the gain in the thermal efficiency of a boiler by use of a live steam feed-water heater has been clearly proved under working conditions. The claims made by Drewitt Halpin, by Mr. Hamilton, by Messrs. Booth and Kershaw, by Colonel Crompton and others, for the advantage and economy of hot feed-water, are therefore at last likely to receive recognition and application from the branch of the engineering profession engaged in the generation of electricity.

Perhaps the most suggestive portion of Mr. Wilkinson's paper, however, is that in which he asserts that a much higher evaporative duty than at present is usual may be obtained from steam boilers by the use of hot feed-water and intensive combustion. He considers that a coal consumption treble or quadruple that at present considered good work is possible, with a boiler plant properly designed and equipped for the new system of working. A method of trebling or quadrupling the steaming power of their present boiler plant by comparatively simple means would thus seem to be within reach of all steam users. Possibly Mr. Wilkinson will follow up this suggestion by carrying out at Harrogate some tests of the live steam feed heater, with still higher rates of fuel consumption than the 29.5 pounds per square foot of grate area, given in number four of his boiler tests. A boiler with a specially large fire grate and combustion chamber would be required to give this method a fair trial, but the cost of providing this would be saved, we believe, in the reduced consumption of fuel; one of the most interesting of Mr. Wilkinson's observations being that at these high rates of combustion the whole flue space of the boiler becomes filled with incandescent gas. A considerable portion of Mr. Wilkinson's paper is devoted to the theoretical side of the subject, and an attempt is made to answer the question, "Why should a boiler show a higher thermal efficiency when fed with water at or near the temperature of ebullition?" The experiments of Sir William Anderson, Sir Frederic Bramwell, Miss Bryant, Mr. Dales and A. W. Hamilton are referred to in this connection. These all prove that the higher the temperature of

the water on the one side of the boiler plate, the greater is the rate of heat transmission from the source of heat on the other side of the plate, and that the maximum of heat transmission occurs during ebullition. Many theories have been advanced by boiler engineers and others to account for this fact. The theory which finds most favor with the author of the paper we are discussing is the following:

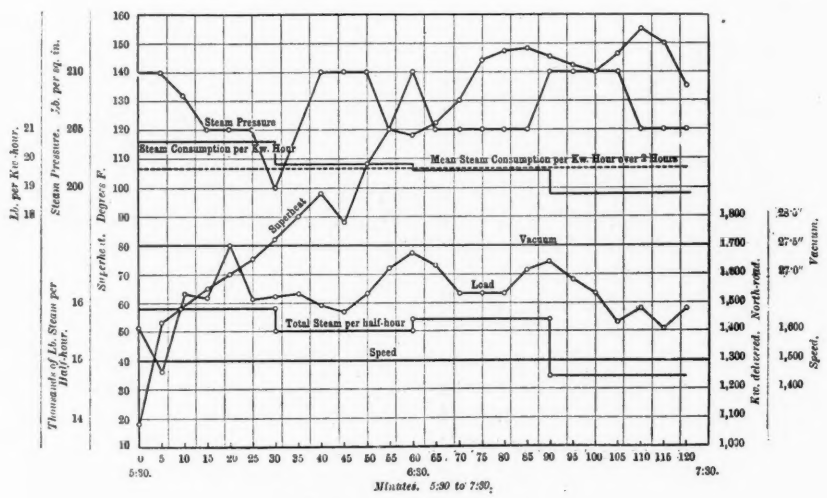
At the moment of its conversion into steam, the water takes up from the plate, with great rapidity, the whole of the thermal energy represented by the latent heat of steam (or about four times that required to raise the temperature of the same volume of water from zero degree Fahrenheit to 212 degrees Fahrenheit). Therefore, at those portions of the boiler where ebullition is occurring, the rate of heat transmission must necessarily be much higher than at those portions where water is being raised to the ebullition point. The objection usually advanced to meet this theory is, that the production of steam from water at the temperature of ebullition does not occur instantaneously at the surface of the plate. A small bubble of steam forms here, it is true, but this detaches itself from the plate almost as soon as it is formed, and as it rises up through the heated water it gains enormously in size. The formation of steam is occurring, in fact, at all stages of its upward journey, and not only at the surface of the boiler plate; and this formation of steam and absorption of heat only ceases when the bubble arrives at the surface of the water and escapes as wet steam. Another objection to the theory advanced by Mr. Wilkinson is that, if true, boilers would produce steam with almost explosive violence, for all the water in contact with the boiler plates would be converted into steam instantaneously. A theory which is proof against all hostile criticism has, in fact, yet to be formulated, and it would be of much assistance in this matter if one could construct a high-pressure boiler of glass or of some other transparent material, which would allow one to see what was occurring during ebullition. Until this is done we fear the exact cause of the gain in thermal efficiency of boilers fed with water at the temperature of the steam will remain unexplained. However, while we thus dismiss the theoretical side of Mr. Wilkinson's paper as of little value, its practical importance is great, and we hope all engineers interested in boiler working and management will read and study the abstract which will be published in a later issue.

Walter A. Vignoles, the author of the second paper, is chief electrical engineer of Grimsby, and his paper entitled "The Efficiency of Steam Plant" is an attempt to explain why the coal consumption is much higher in central generating stations than in marine work. Upon the subject of boiler-house economy, Mr. Vignoles has nothing novel to say, and as he evidently never makes any tests either of his fuel or of his waste gases, we can not regard the plant under his charge as one which is being worked to the fullest advantage. The figures given in Table 4 of Mr. Vignoles' paper confirm this opinion. Under "Plant Economy," Mr. Vignoles tabulates the results of tests made at the Grimsby works, showing the extra steam consumption due to the stand-by and other losses. These losses and the diagrams given in Mr. Vignoles' paper are chiefly interesting to electrical engineers, but his remarks concerning the wasteful steam consumption of the auxiliary engine plant have a more general application. In the tests made at Grimsby, Mr. Vignoles found that the auxiliaries consumed 5.1 pounds of steam per kilowatt-hour as compared with 31.6 pounds for the main engines. Thus nearly one-seventh of the steam generated was used for the auxiliary engine plant. Mr. Vignoles recommends the use of electrically driven pumps in order to reduce these losses.

The two papers which have been discussed above show that electrical engineers are taking an intelligent interest in their steam-raising plant, and are beginning to realize that it is in the boiler house, rather than in the dynamo room, that the greatest scope for improvement and economy lies. Messrs. Booth and Kershaw, in their paper entitled "Fuel Economy in Steam Power Plants," read before the Institution of Electrical Engineers in January, 1905, emphasized the importance of the boiler in the economical generation of electricity, and suggested experiments upon the lines of those carried out by Mr. Wilkinson at Harrogate. It is obvious that both Messrs. Wilkinson and Vignoles have been close students of that paper.

Tests of Turbo-Generators.

In an interesting article appearing in the London *Electrician* for June 22 and 29, the equipment of the new Brighton electric power station of the Brighton corporation is described. This power station is equipped with turbo-generators rated at 1,800 kilowatts. They are of the double-flow Westinghouse-Parsons type, in which steam enters an annular chamber at the centre of the cylinder, first expands in nozzles, and impinges against blading of the compound De Laval type. The steam then continues to flow towards each end of the turbine and enters the Parsons portion, from which it finally finds its way to the condenser. The pressure employed is 180 pounds, with 150 degrees of superheat. The condensers give a vacuum of not less than twenty-seven and one-half inches. The actual conditions during the test are shown graphically in the accompanying diagram, which is reproduced. On an average they are: steam pressure, 206 pounds per square inch; superheat, 123 degrees Fahrenheit; vacuum, twenty-seven and one-half inches; load, 1,780 kilowatts; steam consumption per kilowatt-hour, 19.67 pounds. Although during this test the steam pressure was somewhat above the guarantee, both the superheat and the load were considerably below that called for—factors which count more than steam pressure in turbine operation. Allowing for the conditions, the contractors compute that the steam consumption per kilowatt-hour would be 19.3 pounds, under the guaranteed conditions.



TURBO-GENERATOR TEST.

Spier Falls Power-House.

By C. J. Hopkins.

THE Spier Falls power-house is at present the largest and most important of several operated by the Hudson River Electric Power Company. While the name of this place is familiar to many, yet, on account of its secluded location on the upper Hudson river—about ten miles west of Glens Falls—its characterizing features are not generally known and will undoubtedly be of interest to those unacquainted with them.

That portion of the building which houses the present plant at Spier Falls, having an aggregate capacity of 14,300 kilowatts, was completed in 1905, and extensions to this power-house for the installation of four additional units, which are already well advanced, will give an ultimate capacity of approximately 25,000 kilowatts.

The nominal water head is eighty feet. The present transmission voltage is 30,000 at a frequency of forty cycles per second.

The issue for June 30 of the ELECTRICAL REVIEW contains an article entitled "Towers for the Transmission Line between Ballston and Amsterdam, New York," describing what is perhaps the most recent progress in electrical transmission, that of a 60,000-volt transmission line supported from steel towers spaced 550 feet apart. The development of this line, which is being constructed by the Hudson River Electric Power Company, will attract considerable attention, as the practicability of the 80,000-volt line, designed to transmit power from the Zambesi falls has received severe criticism.

It was not until the year 1900 that, as a result of organization under the direction of Eugene L. Ashley, president of the operating company, now known as the Hudson River Electric Power Company (but for some time after its formation titled the Hudson River Water Power Company), that Spier Falls began to have a commercial value in the eyes of consumers of power. On April 1 of that year the International Contracting Company, with a force of some 600 men, commenced work for the construction of the large dam and power-house now existing, their preliminary operations comprising the digging of test holes, ten feet square, to locate the rock. The contracting company worked till about November 15, 1900, when difficulties arose causing work to be suspended. After some weeks of delay construction was again resumed with renewed energy, the promoting company itself taking charge, employing some 1,100 hands and working day and night. The nature of this undertaking may be partly comprehended by the fact that thirty-three arc lights and twenty Well's lights

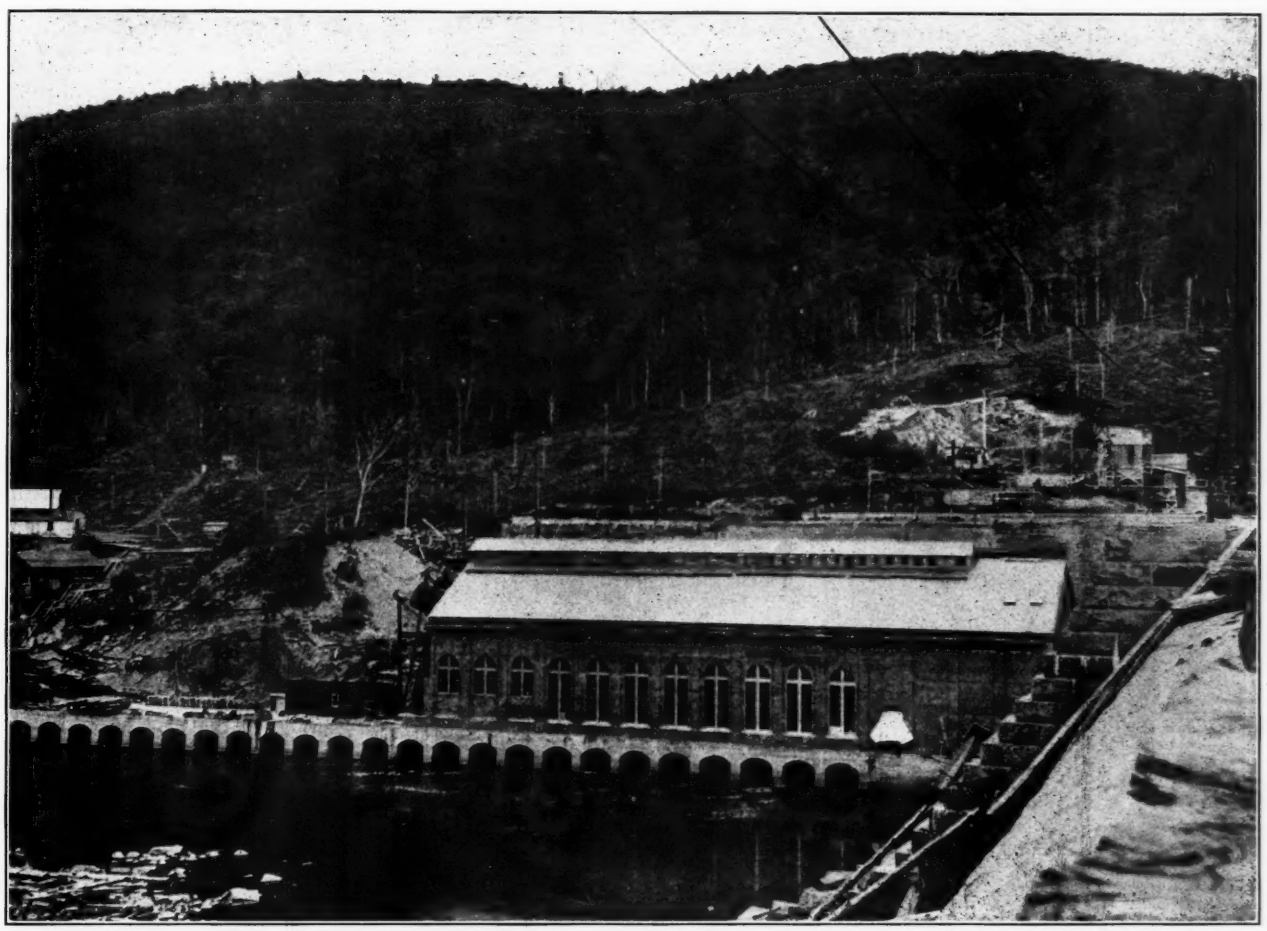


FIG. 1.—GENERAL VIEW OF THE SPIER FALLS POWER-HOUSE AND THE TAIL-RACE. TAKEN DURING A PERIOD OF LOW WATER.

were used throughout the nights. This force of labor was dismissed during the year from the fall of 1903 to that of 1904. Continuous operation of the plant was started in September, 1903, although at this time the dam was incomplete, and a head of sixty-four feet only instead of eighty feet was available, nevertheless, owing to the fact that the turbine ratings are forty per cent greater that the rated capacities of their respective generators, the wheels were able to develop full-rated output and maintain normal speed. At this early stage the protection provided for the apparatus was of a very temporary nature—which together with a somewhat congested arrangement of switch gear did not fail to bring its troubles, especially during electrical storms, or to place the operators in a somewhat nervous state of mind during these periods in particular. This temporary switch house may be seen in Fig. 3.

Power was originally supplied at 15,000 volts. The transmission line in its first stage was not capable of satisfactorily withstanding the higher pressure (30,000 volts) as intended, the insulators being perhaps the weakest link in the chain and accounting for this condition. These insulators were replaced as early as possible by a porcelain type of more liberal design consisting of three sections, having a maximum diameter of eight and one-half inches and an assembled height of seven and one-quarter inches, approximately.

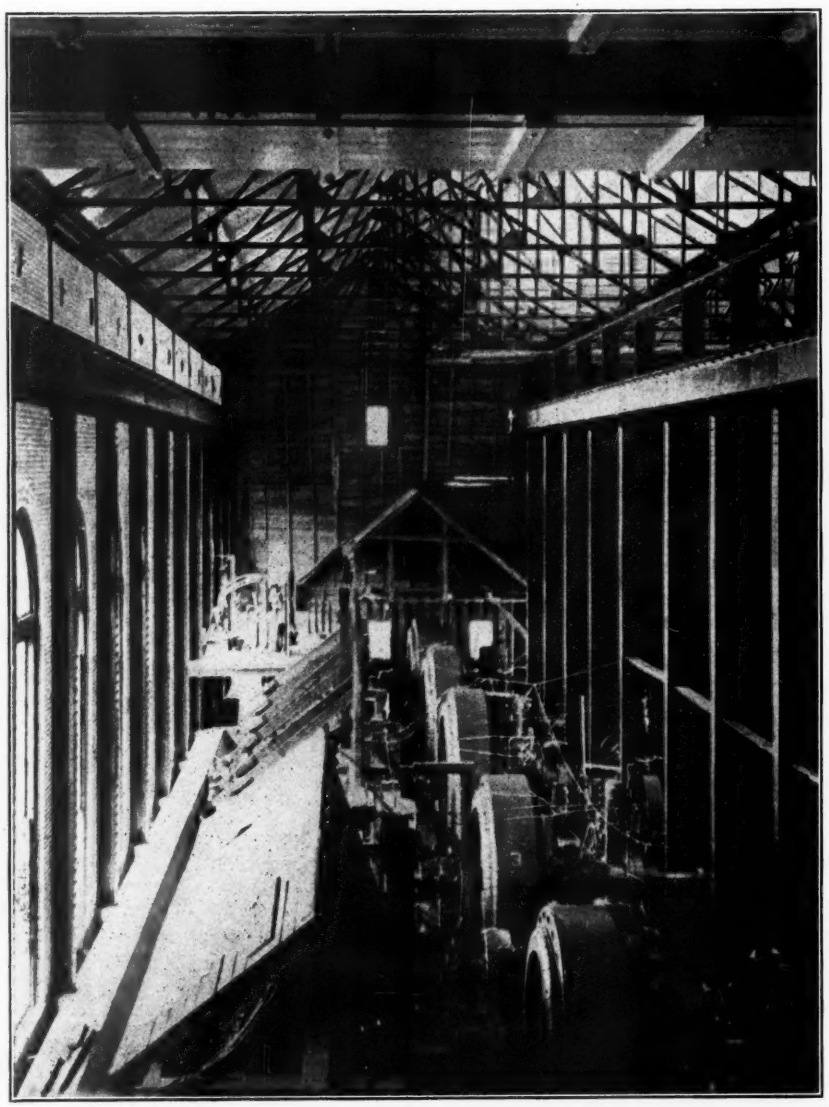


FIG. 2.—INTERIOR VIEW OF SPIER FALLS POWER-HOUSE, SHOWING FIVE OF THE SIX LARGE GENERATORS.

Fig. 1 is a general view of the power-house and tail-race taken from the centre of the dam during a period of low water. The width of the river near the top of the dam is about 1,500 feet, while the highest portion of the dam is about 100 feet above the bed of the river. Before the construction of this dam the fall of the water was slight, assuming more of the nature of rapids; so that the building of this large water barrier necessarily produced a considerable flooding of the country above it, increasing the width of the river some three or four times, and forming a most valuable reservoir, which on account of the formation of the adjacent land did not require any additional lateral fortifications. The property owned by the company in this vicinity is extensive, amounting to some 800 acres. The course of the water which passes over the dam has been diverted from its original channel, now occupied by the tail-race, by a rock partition shown in the lower portion of Fig. 1, thus preventing its interference with the tail-race. It may also be seen from this figure, by comparing the number of arches in the tail-race over which the building stands to the total number, that the ultimate capacity to which it is anticipated the power-house may be extended is about twice its present size; on the other hand it follows from the fact that this photograph was taken from the spillway that there are times in which the water is not too plentiful, thus indicating that unless very extensive reservoirs were provided such a plant could only be operated in its entirety for a few months in the year.

Fig. 2 is an internal view of the power-house taken in the fall of 1905, showing five of the six large generators, No. 1 being excluded.

The entire electrical equipment of this station was manufactured by the General Electric Company, Schenectady, N. Y. It comprises six large units, four of 2,500-kilowatt and two of 2,000-kilowatt capacity each; there is also a small unit of 300 kilowatts. The generated voltage is 2,000 at a frequency of forty cycles per second. The hydraulic plant consists of six large and three small turbine water-wheels, the latter operated as parasites of the large penstocks. The accompanying table gives the types and sizes of these wheels.

Those who are familiar with the operation of hydraulic plants realize the importance of the water-wheel governors in this undertaking. Spier Falls is provided with two types—the Lombard and Sturgess. Experience shows that while similar types of governors may perform their duty satisfactorily in parallel, such is not

necessarily the case when it becomes imperative to run two or more types in a similar manner.

Considering the actuating principles of different types to governors, the reason for the above fact is not difficult to comprehend. The one type being more sensitive than the other tends to take up all the regulation, while the more sluggish will hold its machine at a constant load. Adjustments might possibly be made to offset this difference, but, again, experience shows that owing to the complicated mechanism involved in these machines such manipulations are not very permanent in their effect.

Referring to Fig. 2, the outline of the original temporary wooden structures may be discerned from the remaining portion of the roof in the further end of the building and over the switchboard then in operation. In the far corner of the building is the new switchboard gallery. The new permanent switchboard since completed was damaged by fire a few months ago.

Designation.	Type of Turbine.	Size. Inch Diameter.	Capacity. Horse-Power.	Speed. Revolutions per Minute.
No. 1	Swain, double wheel	54	5,250	240
Nos. 2, 3	McCormick " "	42	4,000	300
Nos. 4, 5, 6, 7	" " "	54	5,250	240
For 300-kilowatt generators	" single "	22	....	400
Exciters 1 & 2 (150 kilowatts each)	" " "	15	....	....

Note—The installation of No. 7 turbine is in progress.

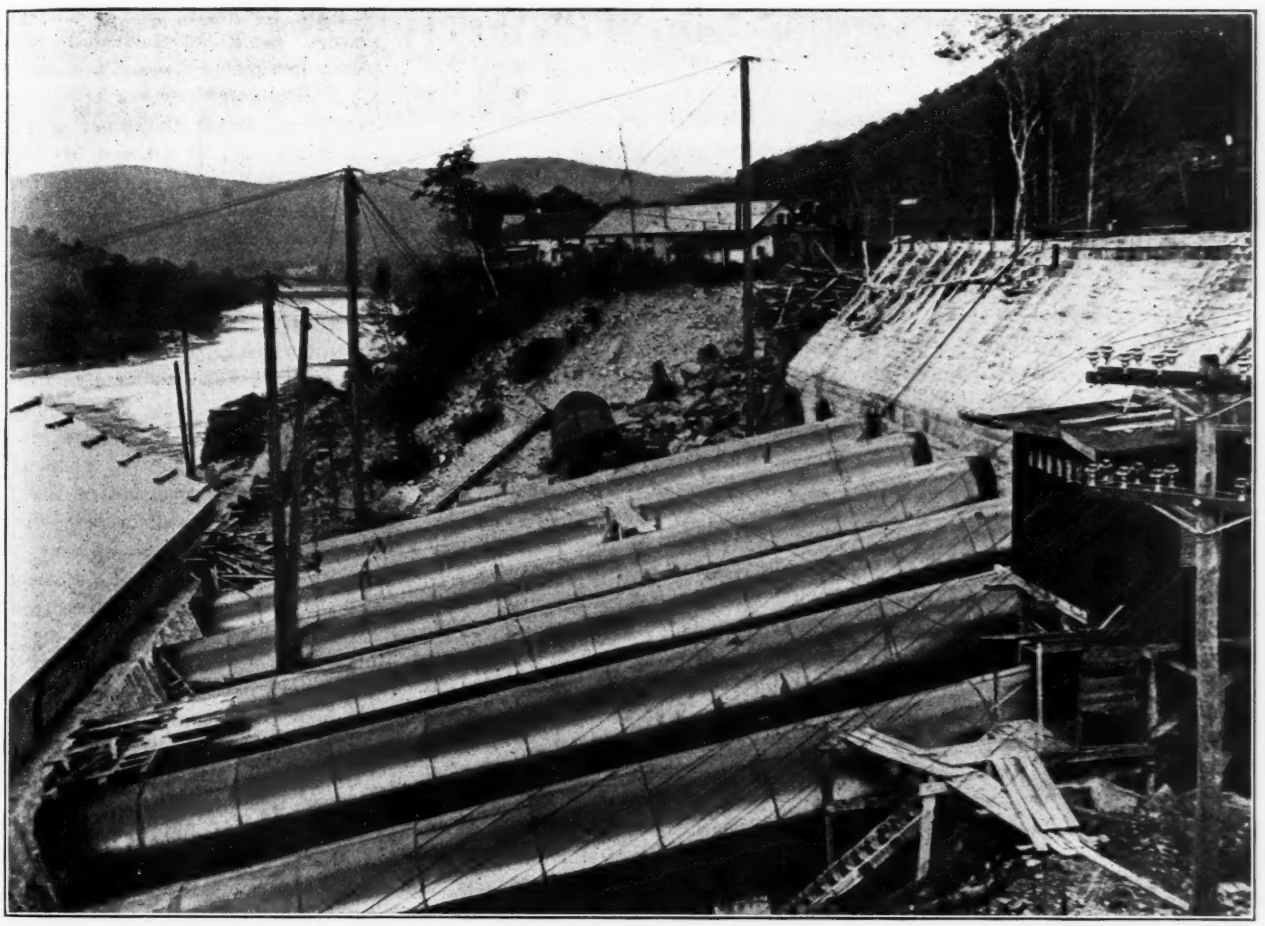


Fig. 3.—Showing the Six Completed Penstocks of the Spier Falls Power-House and Provision for Two Additional in the Rear.

Fig. 3 shows six completed penstocks with provisions for the addition of two similar ones; these are six feet in diameter and about fifty feet in length. In the centre of Fig. 3 may be seen a piece of collapsed penstock—this is of particular interest, as it indicates one of the calamities that may befall such apparatus as the result of atmosphere pressure should the penstock be emptied when the air vent at the head of this enclosed water channel is frozen up or otherwise choked with foreign matter.

The four three-phase transmission lines, which leave the power-house, are shown in Fig. 3, passing over one pole and attached to the same by a double set of insulators—beyond this point the transmission lines are carried on two pole lines, one supporting a No. 000 B. & S. transmission line to Glens Falls and the other two No. 000 lines and one No. 0 line, which after passing through a switch-house in Saratoga, are continued to Ballston substation, whence two lines continue to a terminal at the General Electric Company's works *via* another switch-house at Alplaus, to which point the Mechanicsville power-house feeds direct.

The fact that the Hudson River Electric Power Company owns and operates plants at Mechanicsville and Schoharie Falls, in conjunction with that at Spier Falls, is connecting its recent installation at Utica with this station, has a power-house in course of development on the Sacandaga river, and is also interconnected with the General Electric Company's power-house at Schenectady, makes the supply of power furnished by them most reliable, so much so that a complete shutdown might be termed impossible.

The Bunsen Society Meeting at Dresden.

Important Papers upon the Fixation of Atmospheric Nitrogen.

By John B. C. Kershaw.

THE thirteenth annual meeting of the German Bunsen Society was held at Dresden from May 20 to 23, and was attended by a large number of members of the society, including Nernst, Foerster, Le Blanc and other leading German electrochemists. The recently held International Congress of Chemists at Rome no doubt interfered to some extent with the attendance at this year's meeting of the Bunsen Society.

Following the plan adopted at last year's gathering, a number of papers upon one of the more important subjects of scientific and technical interest at the present time had been arranged, the subject selected for this year's meeting being "The Fixation of Atmospheric Nitrogen." These papers were read and discussed at the first business meeting of the members —on Monday, May 21. As this subject is one which is of considerable interest to chemists, electricians and engineers in all countries, the papers and discussions upon it have been dealt with somewhat fully in this report, and only very brief references to the other papers, likely to be of interest, have been given.

Professor F. Foerster, of Dresden, introduced the subject, "The Fixation of Atmospheric Nitrogen," with a lecture dealing with the chemical and physical properties of nitrogen and its oxides, and outlining briefly the nature and difficulties of the problem presented to electrochemists for solution. It was pointed out by the lecturer that nitrogen was one of the most inactive of the elements at the normal temperature, and that only at very high temperatures did it become chemically active and able to enter into combination with oxygen.

The importance of nitric acid and of its salts (sodium and potassium nitrate) in the arts and industries was next referred to, and the laboratory production of nitrogen oxides by Cavendish and Priestly in 1780, by means of electric spark discharges in air, was described. Bunsen also observed the formation of nitric oxide when exploding mixtures of hydrogen with excess of air. The experiment can be easily repeated and the formation of the brown N_2O_4 observed, when direct current at a pressure of sixty to seventy volts is allowed to spark in air, using iron-wire electrodes. The oxidation or combustion of nitrogen produces no heat, and in this respect it differs from the usual type of combustion. The flame is therefore extinguished unless fed with a continuous supply of electrical energy. The reaction is, however, a thermal and not an electrical one, and the only duty of the electric current is to maintain the nitrogen at the temperature at which it becomes chemically active toward oxygen. The fixation of nitrogen in the form of nitride, by passing the gas over heated cerium, boron, titanium, magnesium or calcium is another method of great chemical interest. Technically, however, it is of no importance, since the recovery of these elements in the metallic state is too costly. The fixation of nitrogen by means of calcium carbide—worked out by Franks—is a third method, of more promise. In this case calcium-cyanamide ($CaCN_2$) is produced, and the compound is of direct value as a manure—apart from its value as an intermediate product in the manufacture of nitrates and ammonia. Professor Foerster concluded with some figures showing the importance of nitrogen —to the agricultural industry. In 1900, 1,300,000 tons of Chili saltpetre were used; in 1905, 1,500,000 tons. Of this enormous total Germany consumed about one-third. In 1900, the total world production of sulphate of ammonia was 500,000 tons, to which total Germany contributed 150,000 tons.

Of this total world production of artificial nitrogen compounds—either in the form of nitrates or of ammonia—agriculture absorbs seventy-five per cent, and the total value of these artificial manures in 1900 amounted to 270,000,000 marks, or $67,500,000.

Professor W. Nernst, of Berlin, then read a paper upon the "Equilibrium and Reaction Velocity Ratios for Nitric Oxide Formation." A proof of the thermal nature of this reaction is found in the fact that the union of nitrogen and oxygen is observed as an explosion phenomenon, with the mixed gases. The chemical laws of mass reaction can therefore be applied to the problem involved in the calculation of the ratios desired.

These constants are of the highest importance for the technical industry, since it is requisite to obtain a concentration of nitric oxide as high as possible in the final gases in the minimum of time. For calculation of the equilibrium ratio the usual equation:

$$K = \frac{(NO)^2}{(O_2)(N_2)}$$

can be applied. In this equation K is a constant independent of the mass of the gases, but dependent upon the temperature; while the chemical symbols within brackets represent the pressures of the component parts of the gas mixtures. The larger the value of K the greater will be the amount of NO obtained from the same gas mixture. It is important for technical purposes to calculate the point at which increased value of K ceases to be remunerative, owing to the increased cost of the electrical energy required for producing the higher temperature which causes it.

In order to obtain the data required for calculating this value, Nernst led air through a platinum or iridium crucible, maintained at the desired temperatures by means of an electric furnace. The gases passing from the crucible were led through a platinum capillary tube in order to obtain rapid cooling of the gas mixture, and were then analyzed to ascertain the NO contents. This rapid cooling is of importance, since otherwise a portion of the already formed NO would be again decomposed: a result due to the declining value of K as the temperature fell.

By rapid cooling of the gas mixture, however, there is what may be called a "freezing in" of the value K, and the composition of the cooled gases is practically the same as at the moment they issued from the heated crucible. From the data obtained by this method, the value of K can be directly obtained.

Another method used for checking the results rests upon the observation of the influence of pressure upon the time of explosion and temperature obtained in "Knallgas" explosions.

Using x to denote the percentage of NO in the exit gases for various temperatures, the values in the following table were obtained.

For calculating the speed of reaction ratio the following equation was used:

$$K = \frac{v_1}{v_2} = \frac{k_1}{k_2} = \frac{(NO)^2}{(O_2)\,(N_2)}$$

in which k_1 and k_2 represent the con-

stants for the speed of combination and dissociation of NO. Now k_1 can be calculated, K is known, and thus k_2 can be

TABLE 1.—PERCENTAGE OF NO IN EXIT GAS.

Calculated.			Values of X.	
			Observed.	Inter-polated.
T.	X.	T.		
1,500°	0.10	1,811°	0.37	0.35
1,800°	0.34	1,877°	0.42	0.43
2,000°	0.61	2,023°	0.52	0.64
2,500°	1.79	2,033°	0.64	0.67
3,000°	3.57	2,195°	0.97	0.98
....	....	2,580°	2.05	2.02
....	....	2,675°	2.23	2.35

ascertained; and from these data the general equation $\log k_1 = AT + B + \frac{C}{T^2}$ was obtained. At high temperatures the last number of this equation disappears, and one thus obtains a straight line ratio between the value for k_1 and the temperature. By use of this method one can therefore obtain the time required for the production of a given amount of NO.

The following are the values obtained for the establishment of a state of half equilibrium, for complete equilibrium—infinite time is, of course, required.

T Degrees.	k_1	t.
1,000	140	81.68 years.
1,500	37,800	1.2 days.
1,900	9.06×10^6	2.08 minutes.
2,100	1.40×10^8	5.06 seconds.
2,500	3.37×10^{10}	1.06×10^{-3} seconds.
2,900	8.07×10^{12}	3.45×10^{-10} seconds.

From this table one sees that the time required diminishes enormously with the increase of temperature. It is nevertheless impossible in actual practice to obtain a gas containing more than three per cent of NO, for the cooling of the gases can not be completed quickly enough to prevent dissociation entirely.

In the discussion upon Nernst's paper the question was raised whether a gas mixture containing fifty per cent each of oxygen and nitrogen would yield better results than ordinary air, for NO production.

Nernst replied that by this plan the yield could be improved by twenty per cent, but that the cost of preparing such a gas mixture would not be balanced by the gain in output of NO.

Professor F. Foerster, of Dresden, followed with a paper upon "The Technical Methods for Carrying Out the Combustion of Nitrogen." The author commenced by stating that theoretical considerations clearly indicated the lines upon which the technical methods must be developed. The gas mixture must be heated to the highest possible temperature, and then must be cooled with the highest possible rapidity.

Muthman and Hofer had found in their experiments that the yield of NO decreased with the increase of electric energy put into the arc. Researches by Brode helped to explain this anomaly. The electric arc consists of a very hot inner core, and of an outer "aureole" of flame, of lower temperature. This "aureole" increases in extent, however, with increase in the electric energy put into the arc. Now NO is only formed in the inner flame; the temperature of the "aureole" causes its dissociation. Therefore increase in the extent of the "aureole" causes increased dissociation.

For this reason better results were obtained in the early trials with spark discharges—as in the case of these, the second zone of flame is of small dimensions.

But an enormous number of sparking points is required, since each represents a very small amount of electrical energy. Bradley and Lovejoy attained this requisite by designing a drum covered with points, which revolved slowly inside another drum similarly provided on its inner surface. With this apparatus they obtained eighty-eight grains of HNO_3 per kilowatt-hour and a concentration of two to three per cent of NO in the issuing gases. Using current at 10,000 volts pressure, the apparatus required only one ampere, and attempts to use a larger current only produced the "aureole" of lower temperature, which it was necessary to suppress. To obtain a large amount of nitric acid from the air by this method would have required, therefore, the construction of many hundreds of these revolving drums, and as they were complicated and costly, the Bradley and Lovejoy process failed.

A sparking process for manufacture of nitric acid might be worked with the aid of condensers, but hitherto electrical condensers have not proved durable when in constant use. Inventors in this domain have, therefore, turned to "flame-arcs" for provision of the heat required, the essential condition of this use being that the arc should be continually in movement, or should be rapidly extinguished and remade. This condition can be best attained by means of a magnetic field, and by use of alternating current for forming the flame-arc. By this method of working, the flame-arc is made to take the shape of a disc, and it has been applied practically to NO production by Messrs. Birkland & Eyde. Their apparatus or furnace consists of a case, one metre high and one metre broad, within which, by means of an alternating current and a magnet, a disc of flame two metres in diameter is produced. The whole interior of the case is, in fact, filled with a sea of flame, and into this the air to be consumed is led. The furnace takes 500 kilowatts of electrical power, ten per cent of this being required for the production and maintenance of the magnetic field. The flame-arc is produced by an alternating current at 5,000 volts. Twenty-five cubic metres of air are led per minute through the flame, and a concentration of two per cent of NO is thereby attained in the issuing gases.

From seventy to eighty-three grams HNO_3 per kilowatt-hour are obtained with this furnace in constant work, this being equivalent to 500-600 kilogrammes per kilowatt-year. Taking the cost of the kilowatt-hour at .60 pfg., this is equivalent to .29 mark (6.8 cents) for the electrical energy required to produce one kilogramme of nitrogen in the form of nitric acid; whereas in sodium nitrate (the Chili saltpetre of commerce) the same amount of nitrogen costs 1.25 marks (thirty-one cents).

In Norway, the nitric acid is converted into calcium nitrate or into the basic nitrate of lime, the latter compound having proved a good fertilizer for agricultural purposes. The annual consumption of 1,500,000 tons of nitrate of soda would require 2,500,000 horse-power to produce by the method just described; but the waste gases of the blast furnaces now in operation in Germany alone would generate 500,000 horse-power if utilized for this purpose.

The author then discussed the theory of the above methods for producing nitrate from the air, and stated that from the results of experiments carried out by himself, with direct and alternating currents, he had concluded it was the amount of electrical energy and not the manner of discharge that influenced the results obtained. Haber had calculated that with a temperature of 4,200 degrees centigrade, and rapid cooling of the final gases, a yield of 212 grammes HNO_3 per kilowatt-hour might be attained; while with a temperature of 3,200 degrees centigrade only 93.5 grammes were attainable. The former figure of 212 grammes is in the author's opinion too high; but the lower limit of 93.5 grammes has already been nearly attained in practice, and an increase of this yield will only come by use of methods which can communicate a higher temperature to the air sent into

the furnace. Further progress in the industry is, therefore, a question for electricians rather than for chemists; although by use of a fifty per cent mixture of nitrogen and oxygen, under pressure, a slight increase in the yield might be obtained.

Such a fifty per cent mixture of oxygen and nitrogen might be won by distillation of liquid air, and the residue of pure nitrogen could then be utilized for preparation of calcium cyanamide by the Frank and Caro process.

Bodenstein, Eskales, Nernst, Brode and Stavenhagen joined in the discussion on this paper.

The next paper of this series upon the fixation of atmospheric nitrogen was contributed by Professor M. Le Blanc, of Karlsruhe, and dealt with the "Estimation of Nitric Oxide (NO) in Air." The author stated that the literature upon this subject was scanty and inaccurate. The method of estimating NO, usually described, was to lead the gas mixture through water, and to determine the nitrate and nitrite present after the absorption. According to the authorities, equivalent amounts of nitrate and nitrite would be produced—as shown by the chemical equation:

$$N_2O_4 + H_2O = HNO_3 + HNO_2$$

The author had found, however, that several conditions influence the results obtained, and that the character of the flame, the length of time during which absorption is occurring and the nature of the absorbent, each influenced the proportion of HNO_2 to HNO_3 obtained in the final solution. Although the difficulties in the way of obtaining a correct estimation are therefore great, by the choice of suitable conditions for the absorptions, a quantitative estimation of the nitrate present in solution is possible. The author finally gave reasons for believing that N_2O_3 and NO_2 were also present at times in the gases pressing from the inner zone of the arc.

The next paper, by Professor J. Klaudy, of Vienna, was upon "The Technical Methods for Converting the Nitrous Gases into Nitric Acid and Its Salts." The author stated that the results obtained in regular work by the larger installations for nitric-acid production from the air, gave a concentration of twenty-seven grammes of NO per cubic metre of air. This was equivalent to 21.6 litres of NO per 1,000 litres of air, or 2.16 per cent, and corresponded to a temperature of 2,600 degrees centigrade in the interior of the furnace. This yield of NO corresponds to 600 kilogrammes of HNO per kilowatt-year; but owing to the dilution of the escaping gas, only a portion of this total can be recovered as nitric acid.

In Norway, the kilowatt-year in certain localities can be obtained by water-power for twenty marks ($5), while in Switzerland and Austria it costs forty marks ($10), and at Niagara eighty marks ($20). Power-gas installations and small water-powers can not, therefore, compete in this new industry, although blast-furnace gases may have a future. Taking the above figures as basis of the calculation, the author finds that in Norway one kilogramme of nitrogen in the form of NO costs only .15 mark ($0.03), while in the form of sodium nitrate or nitric acid, it costs from 1.15 marks to 1.90 marks ($0.28 to $0.48).

The last paper upon this subject was by Dr. Adolf Frank, of Charlottenburg, and dealt with "The Fixation of Atmospheric Nitrogen by Means of Calcium Carbide." This paper covered very much the same ground as the lecture delivered by Dr. Frank before the Congress of Applied Chemistry at Rome on Tuesday, May 1, and a report of this lecture has already appeared in these columns. (See ELECTRICAL REVIEW, June 2.)

Other papers read at the Dresden meeting of the Bunsen Society which may be of interest were the following:

Professor Jäger (Charlottenburg), "Calorimetric Measurements by Means of the Platinum Thermometer."

Dr. F. Fischer (Berlin), "The Formation of Ozone."

Dr. Siedentopf (Jena), "A New Physico-Chemical Microscope."

Dr. Siedentopf (Jena), "Note upon Colloidal Alkali Metals." This paper is of interest in connection with the new method of producing metallic filaments from refractory metals, for incandescent lamps.

Dr. L. Doermer (Hamburg), "Note upon the Structure of Electrolytic Calcium."

Professor R. Lüther (Leipsig), "Note upon Electrolytic Cross-Currents." (Kreisströme.)

Importation of Cryolite.

The quantity of cryolite, a material used in the manufacture of sodium salts, imported during the year 1905 was, according to a bulletin issued by the United States Geological Survey, 1,600 long tons, valued at $22,482. For the preceding year the importations were only 959 tons.

Power Transmission by Means of Gas.

In a paper read recently before the Society of Arts, London, on "Coal Conservation, Power Transmission and Smoke Prevention," the author, H. A. Martin, had the following to say respecting the transmission of power by means of gas:

The cost of transmission will depend very materially on the scale on which it is undertaken. A supply of gas equivalent in heating value to the 15,000,000 tons of coal consumed by London every year can be conveyed from the South Yorkshire coal field, a distance of, say, 173 miles, by a single line of six-foot pipe, with an initial pressure of 480 pounds per square inch, or, not to depend on a single main, by four lines of pipe ranging from three feet to six feet in diameter, with a pressure of 510 pounds. It would not, however, be necessary to supply so large a quantity, for gas, by reason of its higher practical efficiency, would take the place of a much larger amount of coal than would appear from a comparison of their respective calorific values. The actual amount of gas which would be required depends on so many conditions, the effect of which can not be estimated with any approach to accuracy, that it is impossible to say even approximately what it is likely to be. In view of all the facts, however, it is reasonable to suppose that the consumption of gas in London might be increased to four or five times its present amount. Whether or not this rate is actually reached, or whether it is exceeded, the difference in the scale of operation will hardly be such as to make any material difference in the cost. For the sake of a tangible example, I have assumed a consumption of 180,000,000,000 cubic feet per annum, and a maximum demand of 900,000,000 cubic feet per day.

If it were necessary to keep down the cost of transmission to the lowest possible figure, the gas would be conveyed by a single line (or at most two) of steel pipes, increasing in diameter toward the point of delivery, so as to keep down the frictional loss, and to utilize the whole of the pressure for transmission. It will be prudent, however, to increase the number of pipes to four, and, for reasons which will be apparent later on, it may be desirable to deliver the gas at a fairly high pressure. Each main would then be laid with thirty-inch pipes throughout, the thickness varying from one end of the line to the other as the pressure dropped. The weight of gas conveyed per minute would be 4,637 pounds per main, or 18,548 pounds in all,

being about eighty per cent of the carrying capacity of the four mains, with initial and terminal pressures of 500 pounds and 250 pounds, respectively.

The weight of each line would be about 82,000 tons, or 328,000 tons for the four, and their cost at current prices would be about $35,160,000.

To this must be added Parliamentary and other expenses, such as right of way; allowing $5,000,000 for these brings the total cost of the lines up to $40,160,000.

The annual cost of transmission, allowing six per cent for interest, four per cent for depreciation of the pipes, and $75,000 for inspection, repairs, taxes, etc., would be $3,895,000.

To compress the maximum supply of 625,000 cubic feet of gas per minute to a gauge pressure of 500 pounds per square inch requires about 207,000 indicated horse-power. Under ordinary circumstances this power would be most economically obtained by means of producers and gas engines, which, at 0.8 pound of coal per indicated horse-power per hour, would consume some 355,000 tons per annum. There is little doubt that this is much less than the amount of coal consumed by all the coasting steamers, goods and shunting engines, which now carry the coal supply of London. In the present case, however, there happens to be a source of power already available in the gases of combustion from the coke used for carbonizing the coal. These gases leave the retort ovens at a very high temperature, the greater part, if not the whole, of the heat which they contain being generally wasted, whereas by means of suitably arranged boilers they might be made to furnish most, if not all, of the steam required to work the compressors.

It is estimated that the entire cost of the compressor plant would be $12,500,000. The annual cost of running it would be $1,450,000.

Spreading the annual costs of compression and transmission over 180,000,000,000 cubic feet of gas, the cost per 1,000 cubic feet for compression is 0.8 cent and for transmission 2.2 cents.

In transmitting air or gas in pipes there is very little gain in utilizing the whole of the pressure for transmission, because by expanding the gas down to atmosphere we increase its volume, and consequently its velocity, to a very great extent. It follows that the frictional losses in the last few miles of pipe are enormous, involving a corresponding drop of pressure in this part of the main. By delivering the gas under pressure this wasteful expenditure is avoided, and although the amount of gas delivered is, of course, reduced, a simple calculation shows that this reduction is very slight in comparison with the pressure saved.

On the other hand, the residual 250 pounds of pressure represent some three-quarters of the effective work of compression, and by means of suitable engines or motors, such as are used with compressed air, may be made to restore a great part of the power which was expended in this operation.

To compress 1,000 cubic feet per minute to a pressure of 500 pounds, with the moderate total efficiency of sixty-nine per cent, requires the expenditure of 331 indicated horse-power. By utilizing the expansion of the gas, from 250 pounds down to atmosphere, without addition of heat, in a suitable engine with direct-coupled dynamo, some ten kilowatts would be obtained per 1,000 cubic feet per minute, or from the daily supply of 900,000,000 cubic feet delivered, say, 1,000,000 kilowatt-hours. This is on the assumption that the gas expands adiabatically, in which case it would emerge from the motor at a temperature of about 200 degrees Fahrenheit below zero, and with only one-half its normal volume. It will therefore be desirable to heat the gas before it enters the motor, for which purpose from two to three per cent of the expanded gas may economically be utilized. The power developed may thus be increased by something like fifty per cent, giving a daily output of, say, 1,500,000 kilowatt-hours. This, at 1.5 cents per kilowatt-hour, would give a daily revenue of about $23,500, of which station costs would probably absorb one-third; and interest, depreciation and management another third; the amount of these charges depending on the load-factor obtained.

It might not be convenient so to arrange the transmission of the gas that the whole of the current generated therefrom could at all times be utilized, but there is little doubt that the profit on the year's working would yield a handsome return on the cost of maintaining a high terminal pressure.

From a comparison of the actual costs of manufacturing gas in various English towns an average figure of 11.3 cents per 1,000 cubic feet is reached. Adding to this the costs of compression and transmission, and allowing for leakage, costs of distribution, taxes, etc., the selling is found to be twenty-four cents per 1,000 cubic feet, if a profit of 4.4 cents is allowed.

There can be no question, however, that the reduction of the price of gas to anything like forty cents per 1,000 cubic feet would bring about so large an increase in the demand that further reductions would speedily ensue, with the result that nearly the whole of the coal at present consumed in London would be displaced by gas. Even for the generation of electricity, gas at thirty-seven cents would cost less than the coal now consumed by twenty-three out of the twenty-five London electrical undertakings, while Hackney's fuel bill (the lowest of them all) exceeds the equivalent of gas at twenty-five cents. These undertakings, however, would probably find it cheaper to obtain their current from the gas-expanding stations than to generate it themselves.

Turning now to the incidental consequences of gas transmission, and giving due precedence to the fog question, the general supersession of coal by gas would put an end, once for all, to the smoke nuisance, and the abnormal blackness and persistence of the London fog would become a memory of the past. There is no reason why gas should not be piped in the same way to every city and town in the kingdom. To inland towns, indeed, which pay $4.50 or $4.75 for their gas coal, cheap gas would be an even greater boon than to London, with its sea-borne supply. Nor need the benefits of cheap gas be confined to the towns, for there is no reason why the trunk mains should not be tapped at any desired point along the route. The cause of industrial decentralization could be given no greater stimulus than it would receive from the provision of light, heat and power at a minimum cost along every foot of the pipe-lines from the collieries to the metropolis.

Novel Cable-Laying Apparatus.

In Berlin, Germany, the telephone wires are formed into cables of large size, and are laid in cement conduits. To carry this out a gang of ten or twelve men is generally needed, so that a labor-saving device could be a great advantage here. This was found in the shape of a vertical drum operated by an electric motor, which is used for drawing the cables through the conduits. To make it easy of transport, the apparatus is installed upon two separate wagons. The first wagon which forms the current-generating plant contains a six-horse-power petrol motor coupled to a small dynamo. On the second and larger wagon we have a three-horse power motor mounted with the cable drawn. With this apparatus a great saving of time is effected, and in one case a cable of the heaviest type of 600 feet length was drawn through the conduit in seven minutes.

Society for the Promotion of Engineering Education.

The Society for the Promotion of Engineering Education held its fourteenth annual meeting at Cornell University, Ithaca, N. Y., June 28 to July 3. A number of interesting papers were presented, brief abstracts of some of which are given below.

John F. Hayford, in a paper entitled "Why Not Teach About Men, the Most Important and Difficult Tools an Engineer Uses?" said that this is a course which should be taught because of its importance in affecting the success of the man and therefore his usefulness to the community, because the subject matter can not be learned quickly or easily by mere experience, because there are fundamental principles to be followed, in using men, which are teachable, and because of the high cultural value of the course.

It is essential to the success of the engineer that he should know how to estimate the strength and recognize the peculiar properties of the men with whom he is associated, or whose energies he directs, for the same reasons that he must know the strength and properties of the materials with which he deals. A correct judgment of men is more difficult to attain, but is also more important than a correct judgment of materials. The engineer must have both.

James P. Munroe read a paper entitled "The Standards to Be Placed Before the Young Engineer." Much teaching is ineffective, because neither teacher nor pupil sees the true end of education, which is physical, mental, moral, and therefore social, efficiency.

Limiting ourselves to technological schools, few students look beyond the next examination, which they regard simply as an artificial barrier in their race for a degree. The schools of applied science foster this student attitude by multiplying examinations, overloading with "examinable" subjects, and permitting too much intensive specializing. As a result the minor processes often eclipse the major purposes of higher education.

Those major purposes, in the order of their importance, are: to develop manhood out of boyhood; to make men humanly broad-gauged, mentally quick and receptive, intellectually catholic, tolerant and modest; to train good citizens in the broadest sense, and to equip for industrial efficiency. Unless the fourth (and least important) purpose is achieved in such a way as to make for manhood, breadth and active citizenship, the technological school has failed of its educational duty.

The faculties of most schools of applied science have definitely succeeded, against great odds, in upholding the true aims and purposes of higher education. But with the greater speed and specialization of modern life, this will be increasingly difficult, unless they are supported and assisted by bodies of men near enough to understand the problem and yet far enough removed to gauge the final, broad results of technical teaching. Such bodies of men are the trustees and the alumni. Both could and should do more than at present toward making the undergraduates understand and follow those genuine, enduring standards of human efficiency by which the teaching and the lives of all educated youth ought to be governed and inspired.

Paul C. Nugent discussed "The Dual Degree for Engineering Courses." There are now three methods of graduating engineering students: graduation with honors as in colleges of liberal arts; graduation with full engineering degree; graduation with the degree of Bachelor of Science in Engineering, followed by the full degree for additional work. The systems all have their defects, and the author offers a fourth plan as follows: at the end of the regular four or three-year courses let two degrees be granted, the B. S., being given to those who have passed in all the required studies, but who have failed to attain a certain set grade. This grade to take into account (in the case of four-year courses) all the work of the last three years. The required percentage, while reasonably high, should not be as high as that demanded for graduation with honors in liberal arts. Students who attain the required percentage will be given the full degree. Details of the plan will have to be worked out, but it appears to offer no difficulty.

Arthur E. Haynes read a paper entitled "The Justification of the Use of the Expression 'Engineering Mathematics.'" The reasons for the use of this expression are at least three. (1) Because of the main object of study of mathematics in an engineering course—mathematics are to be used as "tools" by the engineer. (2) Because such an object requires a different kind of teaching. The teacher should have been trained as an engineer. (3) Because the content or extent of the field is different from that of ordinary mathematics.

Bassett Jones, Jr., presented a paper on "The Benefit of Philosophy to the Engineering Student." This is said to be the age of the specialist. That every man must devote himself to one thing, that he is only valuable in so far as he knows more about some one subject than any one else. To such a man success is possible, if by success one means that he is to be the slave of business, and that when all is said and done he leaves his business alone behind him.

The young people should at least have some training in those two most useful acquisitions of the mind, imagination and an appreciation of the beautiful. The world is nothing apart from our ideas about it.

To live in the broadest sense of the word; to live completely, that is the greatest thing that education has to teach, and failing in this education is itself a failure. The study of life then should constitute a part of our curriculum.

Report Relating to Trolley Construction, Underground Conduit Construction and Subways for Chicago.

A report has just been submitted by Bion J. Arnold, Chicago, Ill., to the committee on local transportation of the Chicago city council. This report deals with the construction of overhead trolley lines, of underground electric conduit lines and the subways in the city. It supplements the earlier report submitted by Mr. Arnold in 1902. After pointing out the various considerations which enter into these questions, Mr. Arnold recommends that the overhead trolley system be installed in the business districts of the city to such an extent that all through routes outlined in the earlier report can be put into effect. This is with the understanding that when the completed subway system is built the tracks in the business district will be modified to conform to the arrangement shown in the earlier report. It is not thought advisable to construct conduit systems through streets which will later be followed by the subway system. It is further recommended that immediate steps be taken for rehabilitating the present surface systems and for constructing a number of subway systems outlined in this report. Also, the river tunnels, which are to be reconstructed, should be placed at such a level that they can be used as part of the proposed subway system.

The World's Coal Supply.

The German periodical *Stahl und Eisen* estimates Germany's coal supply at 280,000,000,000 tons, and that of Great Britain and Ireland at 193,000,000,000 tons, the total for all Europe being taken as 7,000,000,000,000 tons.

BALANCERS.

BY J. W. SHUSTER.

The article with the above caption, which appeared in the ELECTRICAL REVIEW of March 10, from the pen of Mr. Budd Frankenfield, calls attention to a subject of more than passing interest, both from the operating standpoint and from the theory involved.

Mr. Frankenfield has drawn an interesting comparison between the motor-generator set when used as a balancer on direct-current circuits and the autotransformer when used for the same purpose on alternating circuits.

The fact that a transformer is usually placed on an alternating-current circuit near the point at which any considerable current is delivered, and that it is readily connected for three-wire distribution, has minimized the demand for the autotransformer as a balancer. There are, however, certain cases where this type of apparatus is a great convenience in taking care of the unbalanced load, and of the regulation of the system.

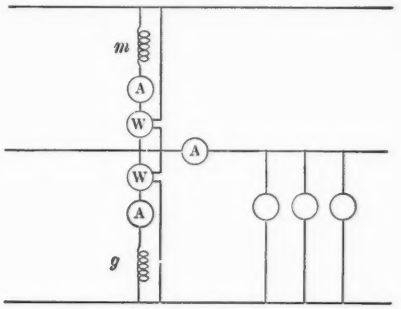


FIG. 1—ARRANGEMENT OF INSTRUMENT FOR BALANCER TEST.

Some of the students in alternating currents at the University of Wisconsin have made tests along the lines referred to by Mr. Frankenfield with results which correspond very closely with the theory as outlined in the above article.

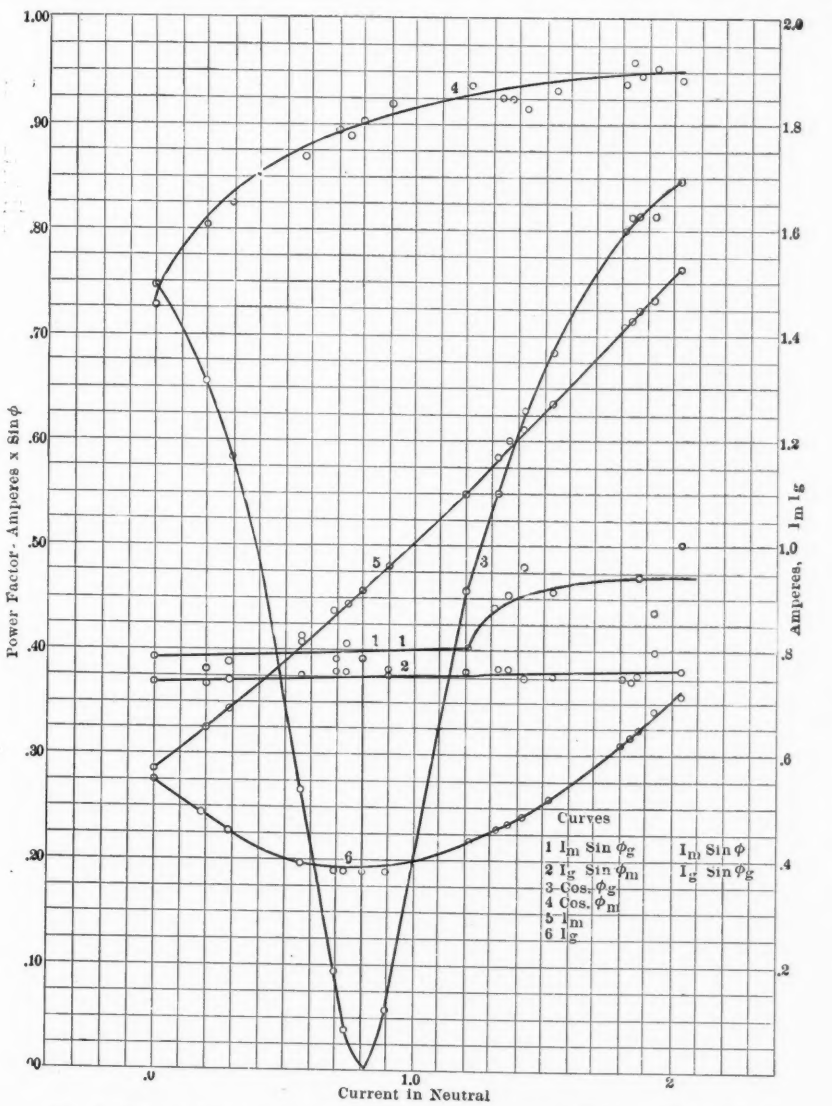


FIG. 2—CURVES SHOWING THE RESULTS OF UNBALANCING TEST OF BALANCER.

The appended curves are taken from data submitted by Messrs. Lewis Fussell and W. E. Wickenden, two of the above-mentioned students.

The observations were taken with no load on one side of the three-wire system and the load on the other side varied by small amounts to show the definite changes of current and power in the two halves of the autotransformer. The instruments were arranged to measure the current, pressure and power on the autotransformer sections as indicated by Fig. 1.

Following the system of nomenclature adopted for the direct-current balancer, the coil on the unloaded side is designated as m and that on the loaded side by g.

Curves 5 and 6, Fig. 2, show the one, the constant gradual increase of I_m as the unbalance of load increases, and the other, the decrease in I_g to the point where I_g equals the constant value of $I_g \sin \phi$, which is the magnetizing current of the autotransformer. From this point power is supplied to the load from g and the current increases.

Curves 1 and 2, Fig. 2, show the magnetizing currents in the balancer to be practically constant, while the core loss currents are varying on the two sides of the balancer.

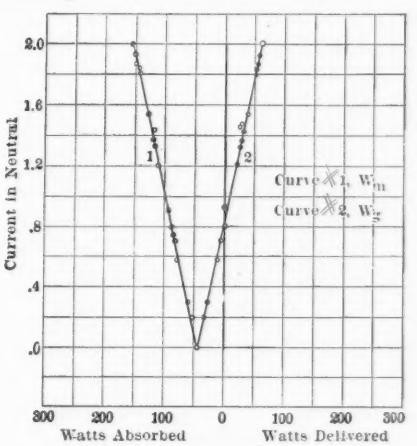


FIG. 3—CURVES SHOWING POWER ABSORBED BY BALANCER.

The power-factor curves 3 and 4, Fig. 2, are of interest, especially curve 3, in showing the point at which the power of g passes through zero.

From curves 1 and 2, Fig. 3, the amount of power absorbed by the balancer, and the power delivered by it as the unbalanced load is increased, may be seen, the watts absorbed and delivered being plotted against current in the neutral.

The erratic bend in the curve between I_m, sin ϕ and current in the neutral indicates an inaccuracy in one of the instruments used here. However, the remainder of the data is very consistent, showing not only a very close agreement with the theory as outlined by Mr. Frankenfield, but also the possibility of measuring the quantities entering and obtaining the relations accurately.

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ELECTRIC PUMPING AT COLLIERIES.[1]

BY GERALD H. J. HOOGHWINKEL.

One of the first applications of electric power to the driving of mining plant was the electrically driven mining pump. The only types of pumps available, until recently, were slow-speed ram, piston or bucket pumps, according to the lift required; but on account of the shorter strokes and smaller masses to be moved, underground direct-driven steam pumps were worked at higher speeds than surface pumps. However, even these comparatively low speeds were not very suitable for coupling to electric motors without the use of gearing. As gearing was thought to be objectionable by most mining engineers, a prejudice which is not shared by the writer, the electrical engineer was asked to reduce the speed of his motor to such a point that two of the great advantages of electric motors, namely, cheapness and small dimensions, almost disappeared. The writer has installed many geared pumps of large dimensions, and they are running satisfactorily and without noise. For small pumps, belt-driving with high-speed motors, which show a high efficiency at various loads, may be used, at least in pump rooms where the atmosphere is not too much saturated with moisture.

The desire to use moderately high-speed motors resulted in the design of high-speed pumps, such as the Riedler, the Bergman and several others, using mechanically aided valves, operated by levers, cams or eccentrics. These high-speed pumps were to be used for high lifts; but lately the speed has been reduced, so as to ensure absolute security from breakdowns, owing to valve troubles, etc. For pumping plant, especially at mines, safety from breakdown is the one and only condition which must be satisfied before everything else, even before high efficiency; and, as will be seen later on, the electric motor has been instrumental in bringing into favor a class of pumping machinery which fulfills this condition, and so far had been very rarely used for underground pumping. The first express pump of large capacity was run at 200 to 300 revolutions per minute, but this speed has been gradually reduced to 120 to 180 revolutions, which is an immense advance on the old-fashioned slow-speed pumps at fifty to eighty revolutions, and still allows of the use of electric motors of fairly economical design and low first cost.

For small pumps the speed may be somewhat higher, and for such pumps belt-driving is advisable, if there is enough space in the pump room: the loss in the belt being equalized by the higher efficiency of the motor.

The latest electrically driven mining pump (in the opinion of the writer, destined to supersede all other pumps and first of all the steam-driven pump) is the electrically driven high-pressure centrifugal pump. The centrifugal pump is, of course, an ideal mining pump, on account of its many and valuable qualities, namely: (1) cheapness, about one-sixth; (2) small dimensions and compactness; (3) strong construction and almost absolute security from breakdown; (4) possibility of pumping dirty and gritty water; (5) small pump room required. The commercial construction of high-pressure centrifugal pumps is of recent date, and is due almost entirely to Sulzer Brothers, of Winterthur, Switzerland. Now, any lift can be attained up to 750 feet with one pump only; and for higher lifts, with two or more pumps in series.

The first large installation erected on this principle was the pumping plant for the Hocayo mines, Spain. Small centrifugal pumps, driven by electric motors, were installed on each pumping-level as the workings increased in depth. The pumps needed no supervision, and the loss of energy, usually incurred by letting the water flow and accumulate in the sump at the pit-bottom, was avoided. Another advantage was that the capacity of the installation could be gradually increased with very little cost. With plunger pumps, either steam or electrically driven, a division of the pumping plant in this manner would be impossible, owing to the high cost and still higher working costs. The water pumped from its proper inflow-level is also much clearer, and has therefore a certain value when brought to the surface.

Modern high-pressure centrifugal pumps may be divided into two distinct classes, namely, the Sulzer pump and the Rateau pump. Various firms on the Continent and in the United States manufacture either of these types on license, or a pump of their own, which may be more or less a combination of both principles.

The Sulzer pump consists of one or more rotating impellers, containing spirally curved guide blades and fixed guide wheels, provided with spirally curved water passages. The water is thrown radially against the fixed guide wheels and through openings in the latter, back again against the blades of the next propeller, which throws it through openings in the periphery of the fixed guide wheel in the pressure chamber surrounding the guide-wheels. Thence, the water flows through channels to the next impeller system or to the discharge if it is a single-stage pump. Gradually the velocity is transformed into pressure by means of expanding channels. This pressure varies, of course, with the speed of the impellers, but it may be taken as about 225 feet of head per impeller stage.

The first important installation of centrifugal pumps of high capacity against a head of over 1,800 feet placed at the pit-bottom was carried out at the Victor-Rauxel colliery, Westphalia. Two pumps are installed in series, each having a capacity of 1,500 gallons of water per minute against a head of 900 feet. This plant has now been running for two years, night and day, without a single hitch. An official test showed the following results: steam engine, ninety per cent; generator, ninety-four per cent; cables, ninety-nine per cent; motor, ninety-three per cent, and pumps seventy-five per cent; the total efficiency being fifty-nine per cent.

The Rateau pump is built on another principle, as the water does not leave the impellers in a radial direction, but in an axial one. In the Sulzer pump the water flows on the impellers in an axial direction and is thrown out radially, but in the Rateau pump the water enters the passages of each impeller at the centre, and, by the rotation, is forced out to a collecting chamber surrounding the periphery of the impeller. The ducts which return the water back to the centre of the impeller are suitably curved to act as guide passages, similar in action to the guide buckets of a turbine. The water then enters the impeller in an axial direction, its rotary motion having been transformed by the guide passage into rectilinear motion.

The efficiency of the Rateau pump is slightly higher than that of the Sulzer pump, and may be taken as between sixty-five and eighty per cent. It can be used for pumping smaller quantities of water at greater heads, while the Sulzer pump is more adapted for large quantities and lower heads.

A recently installed Rateau pump in the Carmaux colliery, France, has a capacity of eighty gallons per minute to a vertical head of 1,350 feet at a speed of 2,900 revolutions per minute.

The electrical part should consist of a high-speed three-phase motor, because it is the cheapest and best-adapted electric motor for mining purposes, and may be

[1] Abstract of a paper read before the Institution of Mining Engineers of Great Britain, June 20.

worked up to an output of 100 horse-power without a starting switch. Instead of the latter it is equipped with a centrifugal compensator, which can be made completely gas-and-water tight, and it cuts out the starting resistances automatically. The point is to construct a motor running at a medium speed and well ventilated, so as to show no high temperature rise after a twenty-four hour's run. Another required condition is the possibility of regulating the position of the stator part of the motor, as the small clearance between the rotor and the stator with three-phase motors (continuous-current motors are not very suitable for underground pumping) soon necessitates a readjustment of the clearance, after continuous running, perhaps for months, without stopping. For large motors it is essential that they be constructed in many parts, so as to permit of easy transport in the shaft and narrow roadways. Motors of a capacity of 200 horse-power and more should be provided with slip-rings, and these can be completely enclosed, so as to be water-and-gas tight. They must be so well ventilated that, after continuous running for any considerable length of time, their temperature limit is not reached.

A three-phase motor of modern construction may be considered free from breakdown, and it is therefore not necessary to provide spare units. It is good practice to mount the motor between two pumps, one being a spare, or between the two cylinders of a two-cylinder pump. Direct driving, although not absolutely necessary, is to be preferred, especially for large sets. If gearing is used bronze wheels and raw-hide pinions should be employed in order to avoid noise, which is most objectionable in a mine, and constitutes a real danger. The motor may also be mounted side by side with a three-cylinder pump, but this arrangement has the disadvantage that all parts of the pump are not so easily reached as with the motor placed in the centre. In the former case, however, the motor should be provided with a revolving mass, either in the rotor or in the shape of a separate fly-wheel, so as to ensure an even turning moment.

Much depends, of course, on the regularity of the pumping. If the flow of water to be removed is constant, then the pumps can be run direct from the mains of a power station. In small pumping plants, if the flow varies very much, the pumps may stand idle during the hours of less flow, but with large installations this is hardly practicable. In the latter case the pumping plant must have its own electric generating plant at the power station, namely, its own dynamo and spare plant, so as to regulate the speed of the pump by influencing the generator field through a separate exciter, and also the steam engine speed. This ensures a speed regulation without incurring the losses of a speed control through resistances. This arrangement is only, however, to be recommended for large pumping plants (300 to 500 horse-power), as the generator-units in the power station will be about that size. In both cases, however, employing either a separate dynamo or direct driven from the mains there should be a starting arrangement in the mine as well, and the motor should be provided with slip-rings. In case of emergency the man in the pump room should not be obliged to ring up the power station, but he should be able to shut down the pumping plant himself.

The pump room in the mine should be built of stone or brick, and as near as possible water-and-gas tight, even in mines which are supposed to be exempt from fire-damp. This brick chamber must be well ventilated and lighted, and serve at the same time as a distributing station for the entire colliery from which the cables to the various workings will radiate inbye. This may seem expensive and wasteful, but the writer has found it to be a saving in the end, as it is so much easier to keep the electric and pumping plant in perfect order, and therefore to economize in repairs and minimize the chance of a breakdown. The longer life of the machinery and of the switch gear are also advantages not to be overlooked.

If the mine is fiery, the switch gear should be of the gas-tight enclosed type, in the case of starters of the liquid type, while switches and fuses, if any, should be of the oil type. The short-circuiting contacts of the liquid starters should be enclosed, and the starter itself provided with a dash-pot, so as to prevent it from being put in or opened too quickly. The switch gear should be protected from accidental contact on the part of the workmen, although the pump room should be closed to them.

A central telephone station should be installed, so as to enable the electrician in the pump room to be warned in time if any accident should occur inbye. The instruments must be made of a strong pattern, of the ironclad type, without flexible connections.

A traveling hand-crane should be provided for inspection and repairing purposes. With high-pressure centrifugal pumps, the dimensions of the pump room may be much smaller, and it is the writer's conviction that for underground pumping the centrifugal high-pressure pump coupled to a three-phase induction motor is the best combination that can be obtained and is bound to replace even modern steam pumps.

In order to show clearly the many advantages of electrically driven pumps placed at the pit bottom, it may be useful to discuss the claims which conservative mining engineers set up against the electric motor as compared with the steam engine. A common complaint is that what is gained by using a slow-speed pump is lost again in the high price of the slow-speed motor. As already pointed out, the pump makers have arrived at a speed for highly efficient pumping machinery (eighty-eight per cent of efficiency) varying between 100 and 200 revolutions per minute, this speed being high enough to enable the electrician to design an efficient electric motor at a reasonable price. This, of course, does not refer to centrifugal pumps, running at speeds which require a cheap electric motor.

Another remark which is often heard is that the electric motor can not be flooded. Of course, no one will claim for the electric motor, at least of any size, that it can work under water for any considerable length of time, this performance being also very difficult for a steam engine.

Sinking pumps can be made to work under water for any length of time, and are then in a very much better position than a steam pump, as the useful cooling effect of the water in the latter case acts as a condenser. But there should always be sufficient spare pumping plant at a mine to cope at any time with an increased volume of water, caused by one of the many mishaps which do occur in mines. If, therefore, the pump room be constructed in such a way as to be practically water proof for at least three or four feet above the bottom level, sufficient time will be afforded, in most cases, to lower the water level, by means of the spare pumps, before the water can enter the pump room.

With electric pumps it is possible to run them from a central power station, and to start or shut down in a few seconds without first communicating with the primary power-producing plant. With steam pumps, it is of course also possible to run several pumps from one battery of boilers; but, in the latter case, the whole of the long steam range must be kept under steam, which is a most waste-

ful process, and has many additional disadvantages, such as heating the shaft.

With hydraulic pumping plants, when starting or shutting down any pumps, the speed of the pressure pump must be regulated in the hydraulic station at the mouth of the mine.

Electric pumping is therefore more flexible and requires less spare plant, as in a central electric power station a reserve is kept for the whole of the electric mining plant. It is also possible to erect the central power station on the most suitable spot, and not necessarily near the mouth of the mine, as is required by steam plant, in order to have the boilers near the winding engine, the biggest steam user. Several incidental advantages can be added, namely, the absence of steam pipes in the shaft, where they are inconvenient and damage the shaft timbering; and the electric cables may be taken down the upcast shaft as well as down the downcast shaft, without interfering with the ventilation.

In the first place, it may be reckoned that a modern electrically driven pump does not cost more than a steam pump. Centrifugal electric pumps cost even less. Therefore, the figures for sinking fund and interest on capital outlay are not more, and if the cables are set against the steam pipes, certainly less, than with steam pumps. In the second place, the repairs of the motors and cables are practically nil, and compare very favorably with those of the steam cylinders and pipes of a steam plant. Further, the most important item in the working-cost figures is the amount of power taken by the pump, and, therefore, also the efficiency.

The losses caused by condensation of the steam in the pipes during stops are entirely avoided. When running, the combined efficiency of the pump and the motor is about the same as that of a steam pump. The same statement holds good if a centrifugal pump is used, as in the latter case the higher motor efficiency partly equalizes the lower efficiency of the centrifugal pump. The chief savings are of course effected in the electric station, where an economical high-speed condensing engine may be used, having a much higher efficiency than the pipes and boiler plant used in running a steam pump.

A practical average value for an electric pumping plant of medium size, calculated by the writer from observations of fifteen large electric plants, is sixty-five per cent from the steam side of the main engine to the water raised by the pump. This represents from sixteen to eighteen pounds of steam per horse-power-hour of useful load, an efficiency which is not often reached with steam pumps.

The individual efficiencies of the different sections of the machinery have been determined, and also constitute a fair average taken over a number of installations, namely, engines, eighty-eight per cent; dynamos, ninety-three per cent, cable, ninety-seven per cent; motor, ninety per cent, and pump, eighty-six per cent.

The efficiency of the express pump is the highest, rising to ninety-five per cent, this figure being the efficiency of the 500-horse-power Riedler pump at the Hausemann colliery. Other express pumps show from ninety to ninety-two per cent of efficiency.

Centrifugal pumps have a lower efficiency, being about seventy-five per cent for Sulzer-type pumps, and eighty per cent for Rateau-type pumps, but their motor efficiency is about four to five per cent higher, so that at the best, the total combined efficiency is always about five per cent less. The larger the capacity, however, the nearer the efficiencies of the two kinds of pumps approach each other.

The lower costs, however, of the combination motor and pump, the lower repairs and maintenance costs, the smaller space and security against breakdowns, are well worth the lower efficiency.

The conditions under which sinking pumps must be calculated to work are entirely different from stationary pumps, and therefore they have to fulfil other requirements. Moreover, very little has as yet been done in this particular branch, for which the adoption of electricity possesses some very marked advantages.

Steam is generally used and the disadvantage of steam pumps for sinking purposes is only too well known. There is the low efficiency and the difficulty in ventilating the shaft bottom and the shaft itself, the room taken up by frequently leaking steam pipes, which even obstruct the shaft to such an extent as to prevent the sinkers from doing their work efficiently.

All these disadvantages disappear at once with the introduction of electricity, and one wonders why any steam sinking pump is still used. One of the reasons is that ram-pumps driven by an electromotor through gearing are not only heavy and cumbersome combinations (not more so, however, than steam pumps), but are also more expensive. It is difficult to render the motor water-tight; and, altogether, when comparing them with pulsometers, where low lifts are concerned, the disadvantages of the steam pump are forgotten in face of the high cost of the electric pump.

The introduction of the high-pressure centrifugal pump, with its simplicity, small dimensions, lightness and high speed, has altered the case, and the writer contends that an electrically driven centrifugal pump is unrivalled for sinking purposes on all points.

The compact design and small dimensions of the electric sinking pump are readily recognized. The construction, though simple, must be carried out in a very thorough manner, and the writer is glad to say that many have now been built on the Continent which yield excellent results.

The motor, mostly three-phase, turns round a vertical axle and must, therefore, be carefully balanced and protected from the dripping water. The weight of the rotating part is carried on a ball-bearing protected by a tightly closing hood, which also encloses the starting device. The lower bearing is formed by the stuffing box of the centrifugal pump. The pump axle is made in one with the motor shaft, and is supported on another bearing fixed in the pump casing. The bottom part of the motor casing is shaped in such a way as to form one with the pump without, however, preventing access to the stuffing box. The top part of the motor casing protects the motor against any water spray. The windings are, of course, extra insulated, so as not to suffer from dampness in the shaft. The starting device is mounted on the pump, as it is found better to stop and start the pump in the shaft at will, without signaling to the surface. The simplest device is the centrifugal automatic starter, which may be used with motors up to 100 horse-power and can be easily enclosed so as to be air-and-water tight. For powerful pumps, in cases where variations of the voltage are not allowed, starting resistances must be used.

The pressure and suction pipes are doubled, while the suction pipe enters the pump from above, thereby partly doing away with the pressure due to the weight of the rotating masses. This arrangement practically removes all pressure from the ball-bearing.

The entire pumping set is slung on two chains, hooked into the eye-bolts, which connect the top and bottom parts of the set. The pump motor and pipes are kept rigidly in line through being connected to the covering of the motor. A steel protecting hood covers the whole pump, and under it are mounted the various regulating appliances, namely, an ammeter, a starter, a main switch and the stop-valve hand-wheel.

These pumps have a compact and mechanical appearance, and their advantages are calculated to bring them into use in a short time.

The Engineering Experiment Station of the University of Illinois.

ONE of the great objects always kept prominently in mind in the developing and directing of the state universities has been the building up of the state's industries. At the time these universities were founded agriculture was the chief industry in many of the states, and, naturally, aiding the farmers in solving the many, and sometimes difficult, problems presented to them became one of the duties of the university. The necessity, however, for encouraging manufacturing works was not forgotten, and but a short time passed before attention was given to preparing the youth of the state for such work. Instruction was given in various kinds of shop practice and in all the arts involved in the making and using of machinery and other materials. From these beginnings have developed the great engineering schools which to-day, in almost every state, form one of the important divisions of the universities.

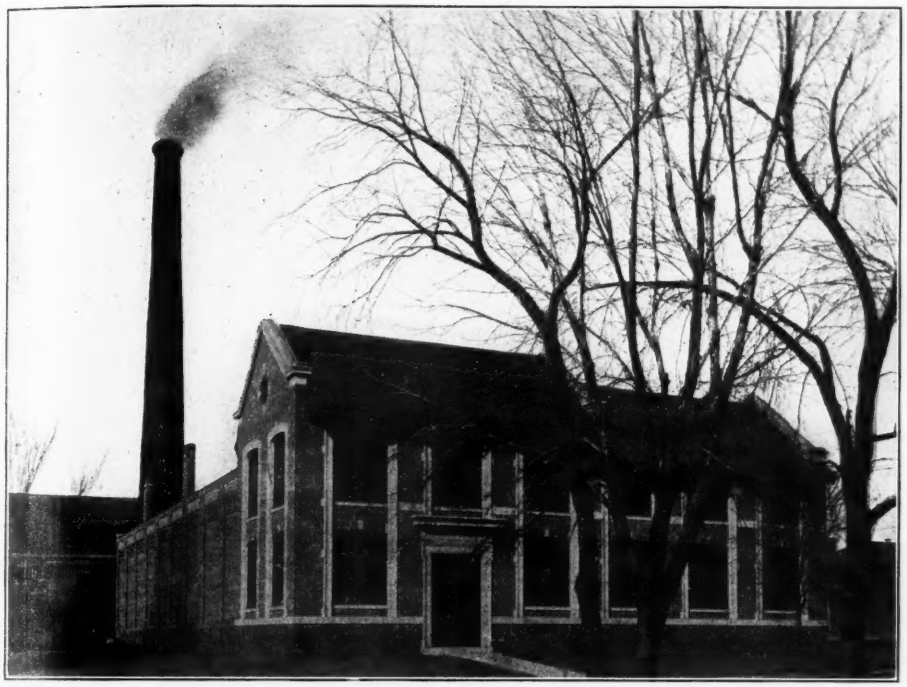


FIG. 1—THE MECHANICAL ENGINEERING LABORATORY OF THE UNIVERSITY OF ILLINOIS—BOILER HOUSES IN THE REAR.

In the endeavor to be of the greatest use to the farmers, agricultural experiment stations have been established at nearly all of these universities in connection with the agricultural schools, and from them a great deal of benefit has resulted. Indeed, the work done at the stations has, in some cases, been almost as important as that in the schools themselves.

Although this extension of the university was so successful it was not followed by the engineering schools for some years. Indeed, only within the last three years have engineering experiment stations been organized. While the members of the engineering faculty were free to consult and aid the state industries as much as possible, the energies of the college were mainly devoted to training young men, though it was the endeavor of the university to make this training the best possible for solving such problems as each man might encounter after graduation. Now a number of experiment stations have been established, with the idea of utilizing the university equipment for investigating such questions as are brought to them, and even for taking up on their own account such problems as seem to offer probabilities of important results.

The experiment station at the University of Illinois, which is believed to be the first of its kind, was established by action of the board of trustees in December, 1903. Similar action was soon taken elsewhere, and already excellent results have been accomplished and problems of considerable importance have been investigated with valuable conclusions.

At the University of Illinois the experiment station is under the control of a director and a station staff, consisting of the heads of the different engineering departments. A corps of assistants is retained, some of whom give all their time to the station work, while others divide their time between it and that of the school.

The equipment at the Illinois station is excellent for this purpose. There is not only a large main engineering building, with its fine draughting rooms and technical libraries, but there are three engi-

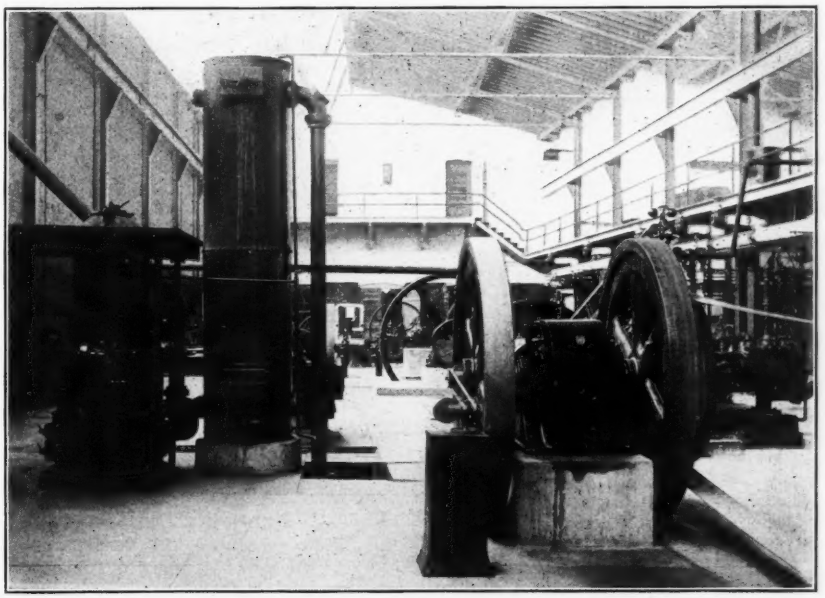


FIG. 2—INTERIOR VIEW OF THE MECHANICAL ENGINEERING LABORATORY—SHOWING POSITION OF THE EQUIPMENT.

neering buildings besides, and, in addition, a fine power plant and shops devoted to woodwork, machine and foundry work. The latest of these buildings to be erected is the mechanical engineering laboratory, completed last year. Fig. 1 gives an external view of this building and shows, just in the rear, the boiler house. In Fig. 2 is given a view of the interior of the laboratory, showing in the foreground a gas producer and gas engine used in experimental tests on Illinois coals. This laboratory equipment includes a 210-horse-power water-tube boiler, which is specially arranged for testing coal. It is fitted with a chain grate and induced draught. There are also a superheater and a number of other boilers, a refrigerating plant, a liquid-air plant, compressed air, various types of steam, gas and gasolene engines, and a steam turbine. The department also operates conjointly with the Illinois Central Railroad a railway test car which has already done valuable work. This is the car that was used in making tests on the New York Central lines preparatory to drawing up plans for electrification at the New York city terminus.

In 1901 the laboratory of applied mechanics was erected at the University of Illinois, an interior view of which is shown in Fig. 3. This laboratory is equipped with apparatus for testing materials and for investigations in hydraulics. The illustration shows a 600,000-pound Riehle test machine in use in testing a twelve-inch by twelve-inch concrete column. In this room there are a 200,000-pound Olsen test machine and three 100,000-pound test machines of different makes. There is also a 220,000-inch-pound-capacity Olsen torsion machine, a machine for making vibratory tests, and smaller apparatus of various types. The hydraulic laboratory, which is just in the rear of the room shown, is thoroughly equipped with pumps, pressure tanks, pipe lines, measuring pits, weirs, gauges and all the other apparatus which go to make up the equipment of such a laboratory.

The electrical engineering laboratory, shown in Fig. 4, contains very complete arrangements for testing all types of electrical machinery. The electric light and power plant of the university is installed in the rear portion of the building, the front part being given up to the dynamo laboratory and instrument rooms. In the basement there is a storage-battery plant, and on the second floor, photometric rooms and a specially equipped illumination laboratory fitted up for studying the effects of light distribution and color in illuminating problems.

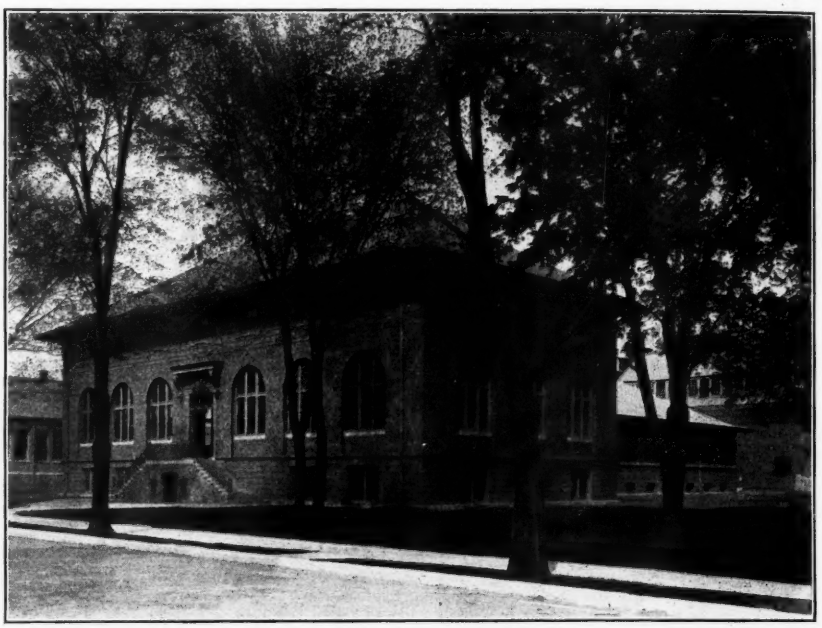


FIG. 4—EXTERIOR OF THE ELECTRICAL ENGINEERING LABORATORY OF THE UNIVERSITY OF ILLINOIS.

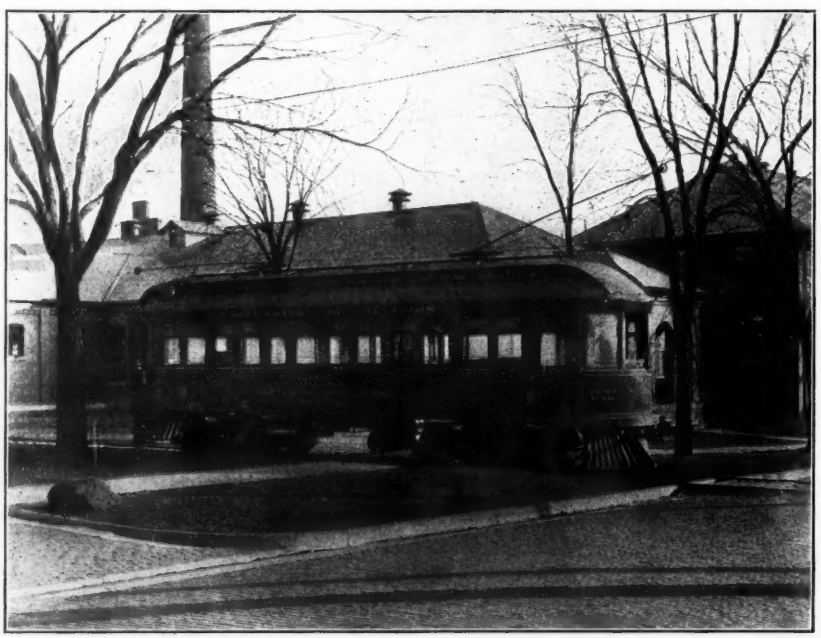


FIG. 5—THE TEST CAR FORMING PART OF THE EQUIPMENT OF THE ELECTRICAL ENGINEERING DEPARTMENT.

The electrical engineering department has recently acquired the electrical test car shown in Fig. 5. This is a car of the standard interurban type, fitted up with the latest type of multiple-unit control and equipped with all the necessary measuring instruments for determining the various factors entering into electric railway problems.

The civil engineering department maintains a laboratory for studying road materials, a subject to which the department has given a great deal of attention. This department also has a cement laboratory for studying questions involved in the manufacture and use of cement and concrete.

The machine and wood shops are well equipped with the modern machines for working metals and iron, which are available for assistance in the problems en-

countered in the work of the engineering experiment station. All departments are exceptionally well equipped with engineering apparatus and instruments, and, in addition, the fine equipments of the physical and chemical laboratory can be utilized when resort to them becomes necessary.

The work which has already been accomplished by the experiment station has been published in bulletins issued by the university. These have described experiments with high-speed tool steels, by L. P. Breckenridge, director of the station, who has been assisted by H. B. Dirks; a study of the drainage of earth roads, by I. O. Baker, professor of civil engineering, and tests of reenforced concrete beams, by A. N. Talbot, professor of applied mechanics. A series of tests on the collapse of boiler tubes has been carried out by the department of physics. A great deal of other work has been done and is now being carried on, the results of which have not been made public.

The station has laid out for itself a number of important problems, some of which have been proposed by the staff; others have been submitted to it. The Department of Agriculture has asked for investigations to be made on heat, light and sound-insulating materials, and on the strength of wooden beams and trestles. The department of civil engineering is extending its studies on road construction and is investigating various problems connected with structural ironwork. The electrical engineering department is making good use of its railway test car in studying railway problems and is studying questions of interior illumination. The mechanical engineering department is continuing the investigation of high-speed tool steels and of Illinois coals, and is also studying the effect of scale in boilers. It is experimenting with superheaters and gas producers, and with other problems connected with power stations. The department of railway engineering is conducting locomotive road tests, and the department of theoretical and applied mechanics is continuing the investigation of concrete beams and columns. It is studying problems involved in the construction of railway cars, is investigating the qualities of commercial mild steels and is carrying out a number of experiments on various hydraulic problems.

The above is but a brief outline of the equipment of the Illinois experiment station and of the work which it is purposed to carry on. There can be but little question of the value of these investigations, not only to the state itself, but to the country at large. In this way it is intended to make the greatest practical use of the excellent engineering equipments of the university, which heretofore have been devoted to the instruction of students only.

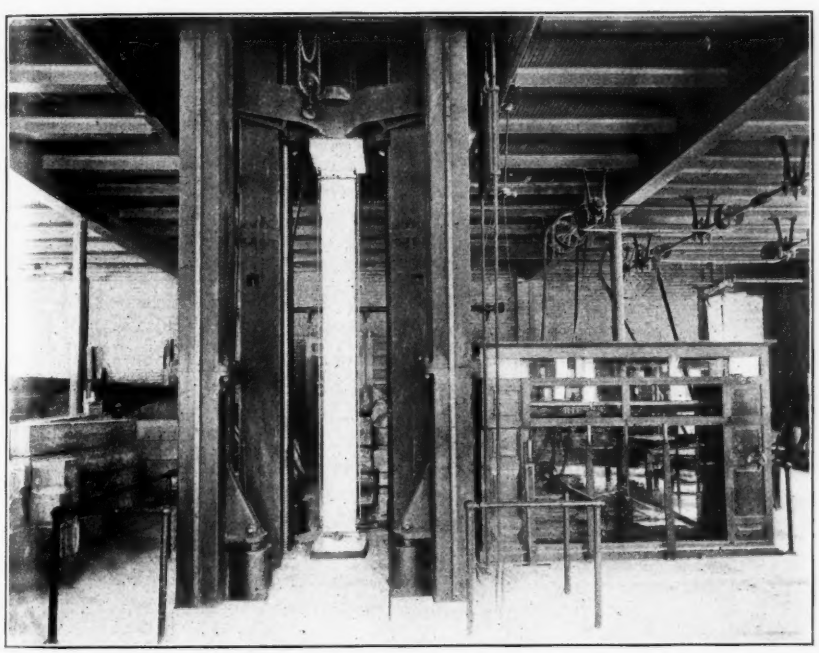


FIG. 3—INTERIOR OF THE LABORATORY OF APPLIED MECHANICS—TESTING A CONCRETE COLUMN.

BOOK REVIEWS.

"The Phantom of the Poles." William Reed. New York. Walter S. Rockey Company. Cloth. 284 pages. 5½ by 8 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $1.50.

The title of this book would have been excellent for a novel, so that it is rather a pity that the author did not treat his subject in this way, for he could then have made an interesting and exciting story. As it is, however, while interesting in parts, as a whole it is disappointing. He seems to have been greatly attracted by the writings of Arctic explorers, and in pondering over the many puzzling natural phenomena observed there has evolved a theory of his own which, he believes, makes all clear. To the ordinary reader his ideas will not appeal, nor will his arguments convince. To adopt the idea of a hollow earth will upset too many physical theories not at all connected with Arctic eccentricities, and the looseness with which scientific expressions are employed seems to indicate a lack of understanding of them. The novelty of his ideas may, however, be interesting.

"Electricity Meters." C. H. W. Gerhardi. New York. The D. Van Nostrand Company. Cloth. 338 pages. 6 by 9 inches. 220 illustrations. Supplied by the ELECTRICAL REVIEW at $4.

In electrical engineering, perhaps more than in any other branch, attention has been paid to methods and apparatus for measuring. In fact, the instrument department of every operating company is of much importance for the success of that company both physically and financially. For this reason much attention has been paid to the design, the construction, the care and the testing of electrical instruments. The author of this book is the chief of the testing department of the Metropolitan Electrical Supply Company, of London, and he deals with the subject from the standpoint of the instrument user. He describes first the various types of alternating-current meters. Following this there is a description of continuous-current meters, in both cases taking up American and European types. This is followed by a chapter on meters suitable for both alternating and continuous-current supplies. Prepayment meters are then described—double tariff meters, maximum demand meters and tram car meters. He then takes up a consideration of choosing a type of meter, explains the best arrangements for a meter-testing room, describes the apparatus necessary, and the best way of installing it. Next, consideration is given to the matter of carrying out a test both in the laboratory and after

installing. Hints are given for the proper installation of meters, for correct reading, for cleaning and repairing, and for record keeping. A number of forms for such records are suggested. The book forms a thorough treatise on the subject of electricity, or, as they are incorrectly called in this country, wattmeters.

"Turbines." W. H. Stuart Garnett. New York. The Macmillan Company. Cloth. 284 pages. 6 by 9 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.75.

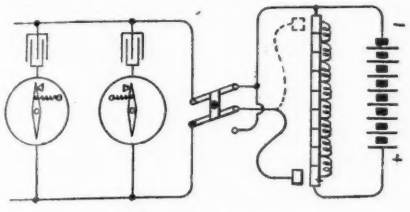
It is not the intention of the author of this book, who, it appears, is a barrister at law, to prepare a text for the designer of any of those prime movers which are grouped as turbines, nor to furnish a guide to the operating engineer which will enable him to run his plant with the most success. It has been his idea, rather, to prepare a popular work which would give to the public and to others interested an accurate discussion of the principles of the turbine and of the different types of construction which have been found successful. The ever-increasing importance of motors of this type seems to have made desirable a presentation of this kind. The first part deals with the historical development of the hydraulic turbine and the evolution of the three great types—the Fourneyron, or outward-flow turbine; the Jonval, or axial flow, and the Howd, though the latter is better known in the form due to Francis. A brief discussion of the theory of turbines is presented in a manner understandable by any one. This is followed by a discussion of impulse wheels and a description of modern designs of the three types of reaction turbines. This part of the book is concluded by a brief chapter on the erection and control of hydro-electric motors. Part II deals with the steam turbine, and after a very brief discussion of reciprocating engines, describes the various types of turbine which have been developed, dealing both with land and marine machines. This part of the work gives descriptions of practically all the steam turbines which have reached the construction stage. An appendix gives a brief consideration of the mathematical principles involved in this class of prime movers.

"Electric Machine Design." Horace Field Parshall and Henry Metcalfe Hobart. New York. John Wiley & Sons. Half morocco. 576 pages. 9 by 11 inches. 648 illustrations. Supplied by the ELECTRICAL REVIEW at $12.50.

The book entitled "Electric Generators," which was brought out some years ago by the authors of the present volume, was an amplification of a series of lectures delivered on this subject by them at the Massachusetts Institute of Technology. The excellence of that volume was well recognized, so that it took a prominent place in the literature of electrical engineering. The present work is really a second edition of the earlier book, though a change in title has seemed desirable. The old text has been revised and a good deal of new matter has been added. This has been necessary on account of the progress which has taken place in the art of designing, improvements not only having been made in the older types, but newer types of machines having been brought out. On account of this additional matter it has been necessary to cut out some parts of the older volume. This has been accomplished generally by omitting certain designs which have become more or less obsolete. The subject is divided into three main divisions. The first relates to the design of the magnetic circuit; the second considers the phenomena of commutation and the study of dimensions; the third relates to the rating of the machine, to determining what has been called the thermal limit of output. In the first part the study of materials is taken up carefully, dealing first with iron, methods of testing, and results of actual experiments are presented. This is followed with a study of insulating materials and methods of testing, and a description of the apparatus essential for this purpose. Following this the principles of armature winding of both direct and alternating-current machines are explained. This is followed by a discussion of formulae for electromotive-force for both classes of apparatus. In this chapter methods of determining the form factor are explained. The authors then take up a discussion of the rating of the machine with respect to the temperature rise, dealing here with the various losses which occur. Next, the design of the magnetic circuit is considered. The laws are applied to direct-current machines, to alternators, induction motors, and to transformers. The question of commutation is taken up in a study of constant-potential, continuous-current dynamos, and a large amount of experimental data is given here, bearing on this subject. This is followed by the specifications for a number of direct-current machines, some of which are very well known. The second part of the book deals with traction motors, direct-current types first being considered, and specifications for a number being given. A good many details in the design of these machines are included. Part III deals with rotary converters in the same thorough manner, designs of a number of machines being given and the methods employed in their operation. Part IV is given up to a consideration of alternators. It treats first of the regulation, then of the determination of the constants of the machine, showing how to predetermine the characteristic curves. Details of construction, as practiced by various builders, are shown here and discussed critically, and a number of noteworthy alternators are described. Part V deals with the design of alternators for steam turbine speeds. It describes a number of typical machines, going into a good deal of detail and including data obtained from actual tests. Part VI considers the design of continuous-current dynamos for turbine speeds, and includes complete specifications for a machine of this type designed by one of the authors. In an appendix to the book are given a copper wire table, showing the properties of commercial wires, and a table giving the electrical properties of various metals and alloys. There is a good subject index and an excellent portrait of Dr. John Hopkinson, to whom the book is dedicated, is given as a frontispiece. The object of the authors has been to furnish constants and formulate the general principles for the systematic design of electrical machines. With this idea in view they have avoided abstruse methods and complicated mathematical processes. In fact, the treatment in general is synthetic, it being thought that better results would be accomplished by following good practice rather than depending on cumbersome mathematical treatments. The particular designs which are described are all of machines which have given good results in practice. The preceding volume included a number of poorer machines, but these, due to a lack of space, have been excluded. Although perhaps unavoidable, this, in one way, is unfortunate, for the designer should know what is bad practice as well as what is good; and where all that is described is good there is danger that he may, when he branches out for himself, fall into pitfalls which might have been pointed out. It is not expected that any one can take this book and from it pick out designs which he can use. Although this might be done and a few good results be accomplished, the designer who adopted this practice would soon be left behind his competitors who were always seeking improvement; but if the principles which are laid down here are grasped thoroughly and then put into practice intelligently, the results undoubtedly will be satisfactory. Taken as a whole, the work is, undoubtedly, one of the best of its class that has even been published, and it will very probably find a place in every designing room.

Electrical Patents.

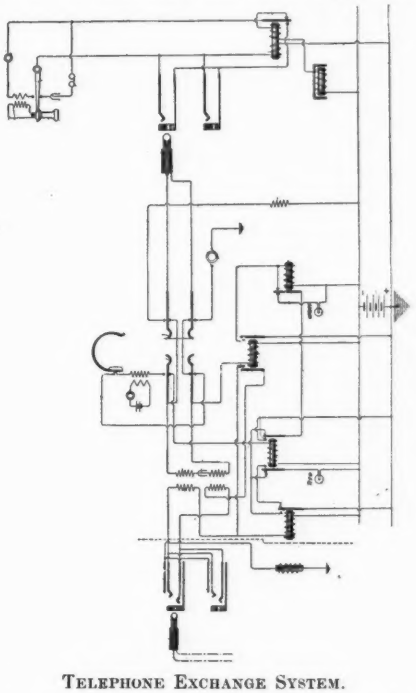
Sylvanus Albert Reed, of New York, has obtained letters-patent of the United States (824,206, June 26, 1906) for an improved selective system. This inven-



SELECTIVE SYSTEM.

tion relates to improvements in systems of electrical selective control capable of application with advantage to a variety of uses, and involves certain principles of operation, which are specially applicable to selective telephone signaling on party lines of the common battery type, wherein the line conductors are normally in open circuit, one of the primary objects of this invention being the production of selective signaling means for lines of this character, which will permit of the use of permanent ground branches from each conductor to contain the signal receiving annunciators and is otherwise capable of application to open circuit lines. The invention comprises two line conductors with open circuit subscribers' apparatus bridged there-across, a pair of polarized oppositely biased annunciators legged from each conductor to a common conductor or ground, condensers in said legs in series with the annunciators, and a source of current, in combination with means for establishing or removing a difference of potential between the opposed condenser surfaces of either line conductor at such rate as will correspond to a strength of current in the annunciators insufficient to overcome the tension of their respective biases.

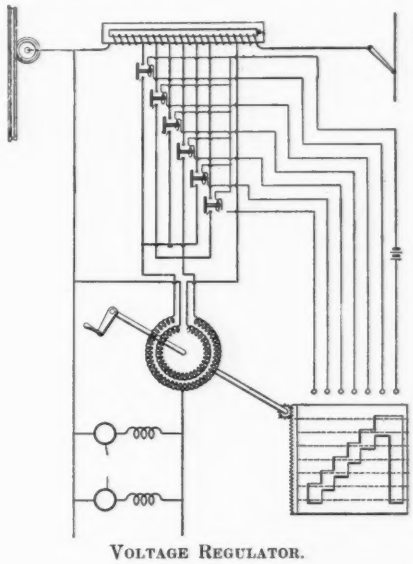
Harry G. Webster, of Chicago, Ill., has obtained letters patent of the United States, No. 824,767, dated July 3, 1906, for an improved telephone exchange system. He has assigned the same to Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y. The invention relates to telephone exchange systems, and more particularly to so-called "trunk circuits," for use in connection with such systems. The invention consists in the combination with a bimetallic trunk-line leading from an A exchange to a B exchange, of a spring jack at the A exchange to contacts of which the terminals of said line are connected, a repeating coil at the B exchange to the outer terminal of one winding of which said metallic line limbs are connected, a subscriber's line circuit connected to the terminals of the second winding of said repeating coil, subscriber's telephone apparatus connected with said line circuit, a subscriber's relay at the B exchange controlled by the operative condition of said telephone apparatus, the continuity of the trunk-line circuit through the first winding of said repeating coil being controlled by the subscriber's relay, an A operator's relay at the B exchange permanently connected to one limb of the line, a red and a white signal lamp at the B exchange each having a local illuminating circuit normally controlled by the A operator's relay, a source of current at the B exchange, and switching means



TELEPHONE EXCHANGE SYSTEM.

associated with the spring jack, whereby the insertion of a cord connecting plug within the jack causes the closure of an electric circuit through the source of current and the relay.

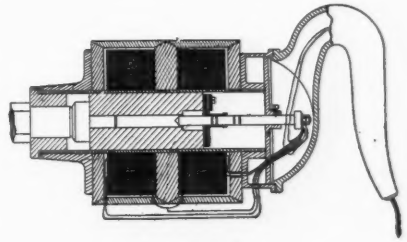
Ragnar Wikander, of Edgewood Park, Pa., has obtained letters-patent of the United States (824,225, June 26, 1906) for an improved voltage regulator, and he has assigned the same to Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. This invention relates to voltage regulators, and particularly to such regulators as vary the voltage applied to a circuit by varying the active length of a transformer winding. The object of the invention is to provide an improved form of regulator of the type specified whereby the voltage may be varied smoothly and gradually between minimum and maximum limits. The invention consists in successively connecting the respective terminals of the secondary winding of the induction regulator to consecutive leads from the transformer winding, a terminal of the distributing circuit being connected to approximately the middle point of the secondary wind-



VOLTAGE REGULATOR.

ing of the regulator. Therefore a smooth and steady variation of the voltage between the minimum and maximum limits is obtained without the occurrence of periods during which no variations in the voltage take place while the regulator is in operation.

An improved electric tool has been invented by Paul Schiemann, of Dresden, Germany. The number of his patent is 824,953, and it is dated July 3, 1906. The present invention relates to electric tools driven by the electromagnetic effect of coils, and its object is to avoid the loss of energy, which is considerable with this class of tools and which is due partly to excessive sparking when switching the



ELECTRIC TOOL.

coils in and out, partly to the excessive heat generated in the tool, partly by eddy currents and partly by the large number of coils necessitated. The invention consists of an electric tool driven by solenoids and having subdivided solenoid coils the parts of which are consecutively short-circuited.

Reviews of Current Engineering and Scientific Literature.

Drawing Submarine Cable with a Locomotive.

A description is given here by Mr. J. Putnam of the laying of a telephone cable across the Connecticut river at Middletown, Ct. On account of the congestion in the four cables owned by the Southern New England Telephone and Telegraph Company it was necessary last spring to lay an additional one. It not being convenient to obtain a tug and lighter from New London, forty-five miles distant, as the ice was at that time going out of the river, another method of laying the cable had to be devised. Nor was it possible, as was done on a former occasion, to lay the cable across the ice, and then, cutting a slot in the ice, allow it to drop through to the bed of the river. The method adopted in this case was to draw the cable through the river from one side by means of a locomotive placed on the other bank. The cable consists of fifty pairs of No. 19 B. & S. copper wire. It is 1,640 feet long and weighs a little over 10,000 pounds. The conductors were insulated first with silk, then with two wrappings of paper. The pairs were twisted together, formed up into a cable, and insulated with paper and sheathed with lead, as is customary. In addition, three layers of jute were laid over the lead, and outside of this an armor of No. 4 Birmingham iron wire. Over the armor were laid two layers of hemp saturated with a preserving compound. To lay the cable, the reel was jacked up in the car on which it was delivered, and to the end was attached one end of a three-eighths-inch seven-strand messenger wire. This wire was then carried out to the middle of the river in a rowboat, where it met another boat coming from the other side with a similar messenger wire. The two ends were then spliced together. The section of the wire from the far side passed through a block attached to a telephone pole, thence through a second block attached to the railroad track, and was fastened to the drawbar of the locomotive. The locomotive then was moved along the track, drawing the cable through the river by means of the messenger wire. Sufficient tension on the cable was maintained by means of brakes on the cable reel, and an emergency brake formed by pressing the cable firmly against a smoothly sawed tree stump with a lever of iron pipe. These precautions were necessary to prevent the current of the river from carrying the cable down stream. Sixteen minutes were required to draw the cable across the river after the first end had entered the water. The work was done without any mishap.—*Abstracted from the American Telephone Journal (New York), July 7.*

High-Speed and High-Voltage Continuous-Current Dynamos.

The rapid progress in the development of the steam turbine has renewed interest in the design of high-speed, direct-current dynamos. The lowest speed at which the steam turbine designer will agree to work is generally higher than that best suited for these generators. It therefore becomes necessary to modify their construction to enable them to utilize the new prime mover. In this article H. M. Hobart describes a 1,000-kilowatt, 1,000-volt, six-pole, direct-current generator designed to run at 1,000 revolutions per minute. A feature of this design is the use of commutating poles to overcome the reactance voltage. This pole is designed without reference to overcoming armature interference. For this reason it is as short in the direction of the shaft as is permissible. On account of the high speed of the machine the diameter of the commutator must be small to avoid immoderately high peripheral speeds. While this low speed is desirable when carbon brushes are to be used, it necessitates a longer commutator in order to keep down the current density at the brush. The author has worked out a number of high-speed, direct-current machines for various voltages and outputs, and has found that the difficulties of the design decrease with increasing voltage. He believes that it is possible to design a 4,000-kilowatt, 2,000-volt generator to run at 500 revolutions per minute which would be a sound machine. In the particular machine described in this article the peripheral speed of the armature is about 160 feet per second. The conductors are held in place by means of hardwood wedges. The commutator is built up on a cast-iron sleeve, permitting access of air through the interior, and the segments are secured against centrifugal force by three steel rings shrunk on over mica bands. The peripheral speed of the commutator is about eighty feet per second. The yoke is of cast iron and the magnet core is of cast steel of elongated cross-section, with rounded ends. A diverter rheostat is connected in parallel with the windings of the commutating poles, enabling them to be adjusted to give good commutation at all loads. The principal dimensions are: diameter of armature, forty inches; length of core, twenty inches; depth of slot, one inch; width of slot, one-quarter inch; average width of tooth, two-tenths inch. The pole faces are twenty inches long, parallel with the shaft, and the mean length of the polar arc is seven and one-quarter inches. The length of the reversing pole parallel to the axis is ten inches and its polar arc is four inches. The radial depth of the air-gap is two-tenths inch, which is a trifle more than that of the main poles. The estimated commercial efficiency of this machine is ninety-six per cent.—*Abstracted from the Electrician (London), June 29.*

Measurement of Alternating Currents.

A method of measuring weak alternating currents has been proposed by Klemencic, which depends upon the heating effect of the current upon a thermo-couple. Two thin wires of iron and constantin were soldered together, and the current passed through these. The heating then set up a thermoelectric force, which could be measured. In amount it depended upon the square of the current, and hence the method is sensitive. This simple arrangement is not thought by Herr J. K. A. Wertheim-Salomonson to be sufficiently accurate, because the junction loses sensitiveness when solder is used, and unless the two wires be soldered together the contact is uncertain. He has devised an improvement in this method which overcomes the difficulties. He arranges a number of thermo-couples in two circuits, connected up in the method employed in the Wheatstone bridge. The alternating current is passed through this double circuit from two points, and the galvanometer connections are taken off at two other points. The arrangement is such that the difference of potential between the two galvanometer terminals due to the alternating current is zero, while the thermal electromotive forces add together to force a current through this circuit. He has used an apparatus of this kind with ten thermo-couples in each side of the bridge. Each row had a resistance of sixty ohms and gave deflections of the galvanometer proportional to the square of the current. Its sensitiveness was such that a current

of one milliampere sets up a difference of potential of 7.5 microvolts. With the galvanometer employed he is able to detect a current of 2×10^{-5} ampere.—*Translated and abstracted from Physikalische Zeitschrift (Leipsic), July 1.*

A Rateau Exhaust Steam Turbine Plant.

A description is given here of an installation of a Rateau exhaust-steam accumulator and turbine at the Hallside works of the Steel Company of Scotland. This plant deals with the exhaust steam from one high-pressure cogging engine with two cylinders, each forty inches in diameter, and a five-foot stroke, one finishing train engine, with two cylinders, forty-two inches in diameter and a five-foot stroke, and two small mill engines and four steam hammers. The total amount of steam from these engines is about 41,000 pounds per hour. The power to be generated from the exhaust is required for lighting purposes and for the driving of live rolls, saws, sand-blast apparatus, machine tools, etc. It was decided to adopt for driving these machines electric power at 230 volts. The accumulator is of the Rateau water-type, having two compartments. It separates any oil carried over by the steam from the water, and it maintains the water in energetic circulation. The steam passing into this accumulator from the engines is condensed whenever the back pressure is above a certain amount; and, on the other hand, if the back pressure falls, the hot water immediately sets free steam at a low pressure. The accumulator is eleven feet six inches in diameter and thirty-four inches in length. It is capable of handling the load on two turbines for six minutes with the main engine stopped. The turbine is rated at 700 horse-power. The wheels are forty inches in diameter, and there are eleven sets of blades. The machine develops full power at a speed of 1,500 revolutions per minute, and when working on an overload of ten per cent the pressure at the inlet is never more than twelve pounds absolute. The vacuum maintained at the present time is about twenty-eight inches. Since the generator must deliver 2,000 amperes, special care was taken in the design of the commutator. The brushes are of carbon and the commutator bars have special ventilating ducts through the centre. A fan blade is attached to each bar so as to maintain the circulation of air through these ducts. After this unit was installed it was run at full load for two weeks, day and night, without stopping, except on Sunday. During this test the regulation did not vary more than five per cent, nor did the temperature rise above a safe point. Tests of this unit have shown a consumption of 66.4 pounds of steam per kilowatt-hour, with a load of only sixty-nine kilowatts, and with the absolute pressure of the steam on entering the turbine 2.9 pounds per square inch. With a load of 196 kilowatts the consumption was 42.1 pounds of steam per kilowatt-hour, and the absolute pressure of the steam on entering the turbine 5.35 pounds. With a load of 345 kilowatts the consumption was thirty-seven pounds of steam per kilowatt-hour, and the pressure on entering the turbine 8.25 pounds. With a load of 450 kilowatts the consumption was 36.6 pounds of steam and the pressure 11.4 pounds. During these tests the vacuum fell from 28.7 inches for the lightest load to 27.9 inches for the last named.—*Abstracted from Engineering (London), June 29.*

The Creplet System of Hoisting for Mines.

This system, which is described here by M. R. de Valbreuze, is thought to be simpler than the Ilgner system and to have some advantages which the latter does not possess. In the Ilgner system the variations in load are absorbed by means of a motor-generator equipped with a heavy flywheel. In the Creplet system the motor is done away with. The generator is connected in series with the hoisting motor, and on the shaft of the former is placed the absorbing wheel. The object of this is to maintain a constant load on the supply system and to do away with one machine. In the other systems either the motor or generator is idle when the other one is at work. In this system the machine acts at one time as a motor, accelerating its flywheel, and then as a generator, supplying the additional load used in accelerating the winding motor. The system is controlled by regulating the excitation of the balancing generator, but the motor is reversed by reversing the armature connections, which is done without opening the main circuit. An installation has been in use at the mines of Hasard & Fléron. The main power supply to the motors is by means of three-phase current at 2,000 volts, but a motor-generator set has been installed to supply the power for hoisting. The height of the lift is about 950 feet, the speed about thirteen feet a second, and the weight of the cage, loaded, a little over a ton. The generator attached to the flywheel is capable of delivering 150 horse-power. The flywheel weighs three and one-quarter tons. The speed variation is from 600 to 275 revolutions per minute, a variation much greater than that obtainable in the other systems. A test made with this equipment showed that the mean useful horse-power was sixteen and one-half, the mean consumption of power 35.7 kilowatts. The overall efficiency of the installation was thirty-four per cent. This was during a day in which 8,850 tons of coal were extracted. On another day, when 10,800 tons were extracted, the overall efficiency was thirty-three per cent.—*Translated and abstracted from L'Éclairage Électrique (Paris), June 30.*

Apparatus for the Production of Pure Ozone.

The apparatus described in this article by M. Albert Breydel is intended to produce pure ozone economically. Apparatus for producing this substance have been devised previously, but they do not attempt to prevent the formation of other substances when free air is employed as the raw material. Impurities are formed, sometimes ammonia or other compounds of nitrogen, and when metallic electrodes are employed, vapors of these metals will be found in the resulting gas. This particular arrangement is designed to avoid such contamination, as the ozone is sought for medical purposes or other uses in which purity is necessary. It is made by passing pure ozygen through the ozonizer, the oxygen being obtained from the ordinary oxygen cylinders. It is therefore desirable that the apparatus should have a high efficiency as an ozone producer, and, to accomplish this, the oxygen is cooled before passing to the ozonizer. When treated in this way the proportion of ozone produced is increased considerably, particularly if the gas first be thoroughly dried. The method consists in drawing the oxygen from the cylinder, passing it through a drying chamber containing calcium carbide, thence through a worm submerged in a cooling mixture, and thence through the ozonizer proper. To avoid contamination due to the electrodes, the latter consist of very thin films of metal placed between glass plates. A number of such electrodes are arranged in a battery, alternate ones being connected to the opposite poles of the source of potential. This source is preferable to a static influence machine, although any source of high potential may be employed. It is necessary, however, to attach Leyden jars or some other capacity to the two sides of the circuit, and to cause oscillating discharges to take place in the air. When this is done the oscillations set up cause brush discharges to take place within the ozonizer, and bring about the transformation of the oxygen. No figures are given showing the efficiency of the apparatus.—*Translated and abstracted from La Revue Pratique de L'Électricité (Paris), June 20.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

Herewith we present four samples of printing which have come to hand recently, each of which bears some hallmark of distinction. It is unfortunate that the reproduction is not in the original colors, for, with these samples particularly, the color scheme has much to do with the attractiveness and utility of the printed matter.

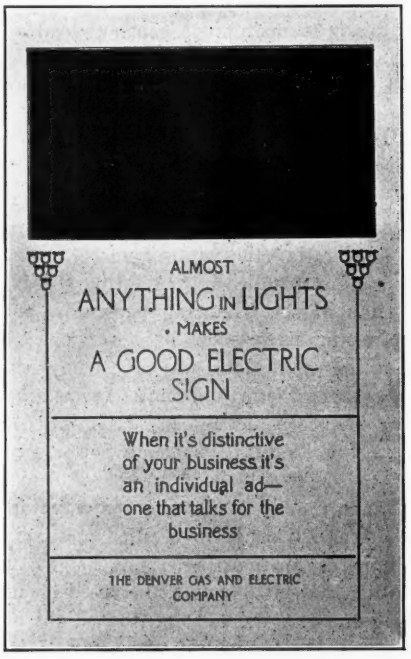
The first sample is from the Brooklyn Edison Company and is a simple dodger, five and one-quarter by eight and one-quarter inches, printed a soft brown on white stock. The circular is timely and calls attention to the advantages of the electric light and the electric fan during

Seeking "Coolth"
NOT so long ago we were all huddling up close to the fire seeking warmth. Times have changed. We are now wiping the perspiration from our brows and seeking "coolth."
Right here is where Edison service helps you out and proves a boon, either in home or store. Electric light is a cool light and does not heat up your premises. That's negative coolth. Also, with the same current that gives you the light, you can operate an electric fan, and keep cool effectively without any effort on your part. That's positive coolth.
In fact summer is a season when Edison service spells health and comfort to the many who cannot seek mountain or seashore, but are obliged to stay at home. And this beneficent service is now in Brooklyn, *cheap*; every man not positively poverty stricken can well afford to enjoy its matchless comforts and conveniences.
If your home or store is not yet equipped for electricity, it's time, it's time! Maybe we can help you toward this desirable consummation. Write us about it and we will call and talk the matter over with you. Take pen in hand now—it won't take you but a moment. Address
Edison Electric Illuminating Company
Of Brooklyn
360 Pearl Street Brooklyn, N. Y.

the heated period. The play upon the coined word "coolth" is clever and holds the attention until its whole meaning is grasped, giving time for the suggestion to leave a permanent impression upon one's mind.

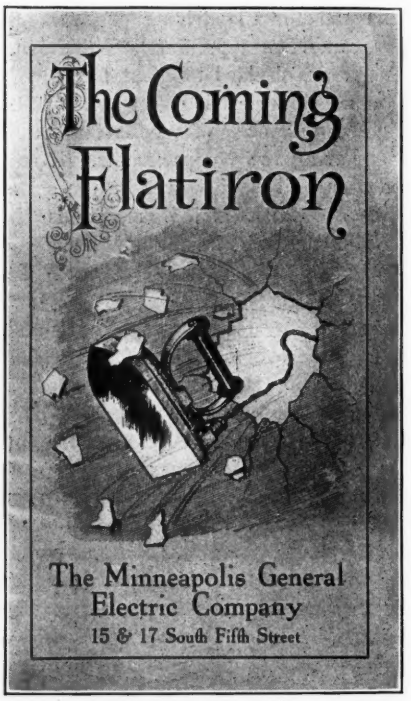
The second and third samples are from the Denver Gas and Electric Company. The first of the two is printed in red and black on a cream stock, three and one-half by five and one-half inches. The statement "if your name is flashed forth like this none can fail to see it," is to the point. The other sample is an example of attractive printing rather than a striking argument for the use of electric signs. The light pink stock is the

PLYMOUTH
If your name is flashed forth like this none can fail to see it. That's the way of
ELECTRIC SIGNS
Letters in lights talk for business steadily. Why not set one to talking for you ?
THE DENVER GAS AND ELECTRIC COMPANY


ALMOST
ANYTHING IN LIGHTS
MAKES
A GOOD ELECTRIC SIGN
When it's distinctive of your business it's an individual ad—one that talks for the business
THE DENVER GAS AND ELECTRIC COMPANY

same size as the card just mentioned, and the color scheme is black and red. The over-printing, black on red, at the top of the card is very catchy, the definition being lost, however, in the photo-engraved reproduction.

The fourth sample is a cover page of a very neat brochure published by the Minneapolis General Electric Company. The frontispiece inside is a photographic reproduction illustrating the electric flatiron in practical service. The brochure explains the operation of the electric iron, the cost of operation, and offers the iron for less than cost on a thirty days' trial, and guarantees them for one year. This offer is not made to the general public, but is made exclusively to consumers of electricity on the company's circuits. This policy is a decided departure from that recently described by S. M. Kennedy, of Los Angeles, where, after several other expedients had been tried, the company invested in several thousand irons, turned them over to consumers on a loaning agreement and built up in short time a profitable load. The competitive conditions of two cities, however, may be so different that while this scheme would be splendidly successful in one place it would entail positive losses in another.



INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

"American" Portable Voltmeters and Ammeters.

The accompanying illustration shows an instrument of a new line of portable direct-current voltmeters and ammeters which has been brought out by the American Instrument Company, Newark, N. J. They are of the moving-coil type, the fixed part being a permanent magnet. Especial attention is directed to the pivots of the new instruments, which are of steel and are cylindrical and journaled into

NEW TYPE PORTABLE VOLTMETER.

watch jewels. This construction, it is claimed, reduces the danger to the jewels from shocks and jars encountered in ordinary usage, and also minimizes friction. The permanent magnets are made of the best magnet steel, carefully hardened and aged. The moving systems are light and stiff, so that with the type of pivot employed there is no danger of their striking against the pole pieces.

Special attention has been paid to the winding of the moving coils, so as to obtain a somewhat larger torque than that usually employed. This enables stronger controlling springs to be used and minimizes any zero errors due to friction. The resistance of the portable voltmeters is wound non-inductively and is designed to have a negligible temperature coefficient.

A feature of this line of instruments is the interchangeability of voltmeter multipliers and ammeter shunts. All voltmeters are adjusted to a uniform resistance of 100 ohms per volt, so that any multiplier may be used with any voltmeter. The portable voltmeters are self-contained up to and including 750 volts, but ranges beyond this are provided for by the use of external multipliers.

The ammeters are self-contained up to and including 200 amperes, but when it is desired to use one ammeter through several ranges a millivoltmeter and separate interchangeable shunts are employed. The millivoltmeter, with its leads, has a resistance of one ohm, and can give a full scale deflection with a potential difference of fifty millivolts. The ammeter shunts are adjusted for a potential drop of fifty millivolts at full current, consequently, any millivoltmeter may be used with any shunt and read correctly.

The portable instruments are made in two types, designated as No. 4 and No. 5. The No. 4 instruments are provided with special iron shields inside of the wood cases, so that they can be used close to large generators. The No. 5 instruments are not provided with this shield and are consequently lighter and somewhat smaller.

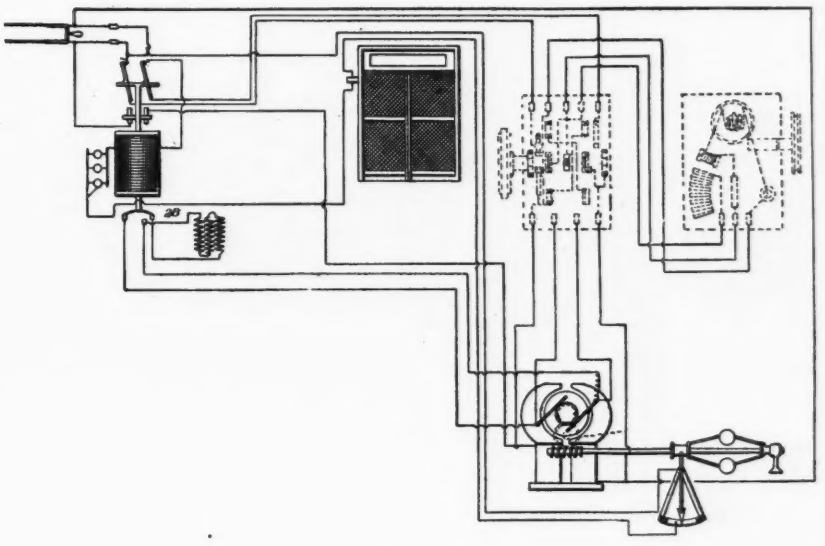
These voltmeters and ammeters are guaranteed correct within one-half of one per cent. The company will also test them and recalibrate them any time within twelve months free of charge, if they are returned to the factory with the seals unbroken.

The general sales office of the American Instrument Company is at 1114 Chestnut street, Philadelphia, Pa.

Safety System for Elevators.

A safety system for elevators operated by any power has been invented by Mr. John A. Miller, and is being put upon the market by the Safety Device Company, Bond Building, Washington, D. C. The object of this device is to prevent the man in charge from starting the elevator until the door has been closed. This is accomplished by means of a set of switches, one located at each door, and all being connected in series. These switches are closed by the act of shutting the door, and the safety circuit is only completed when all doors are closed.

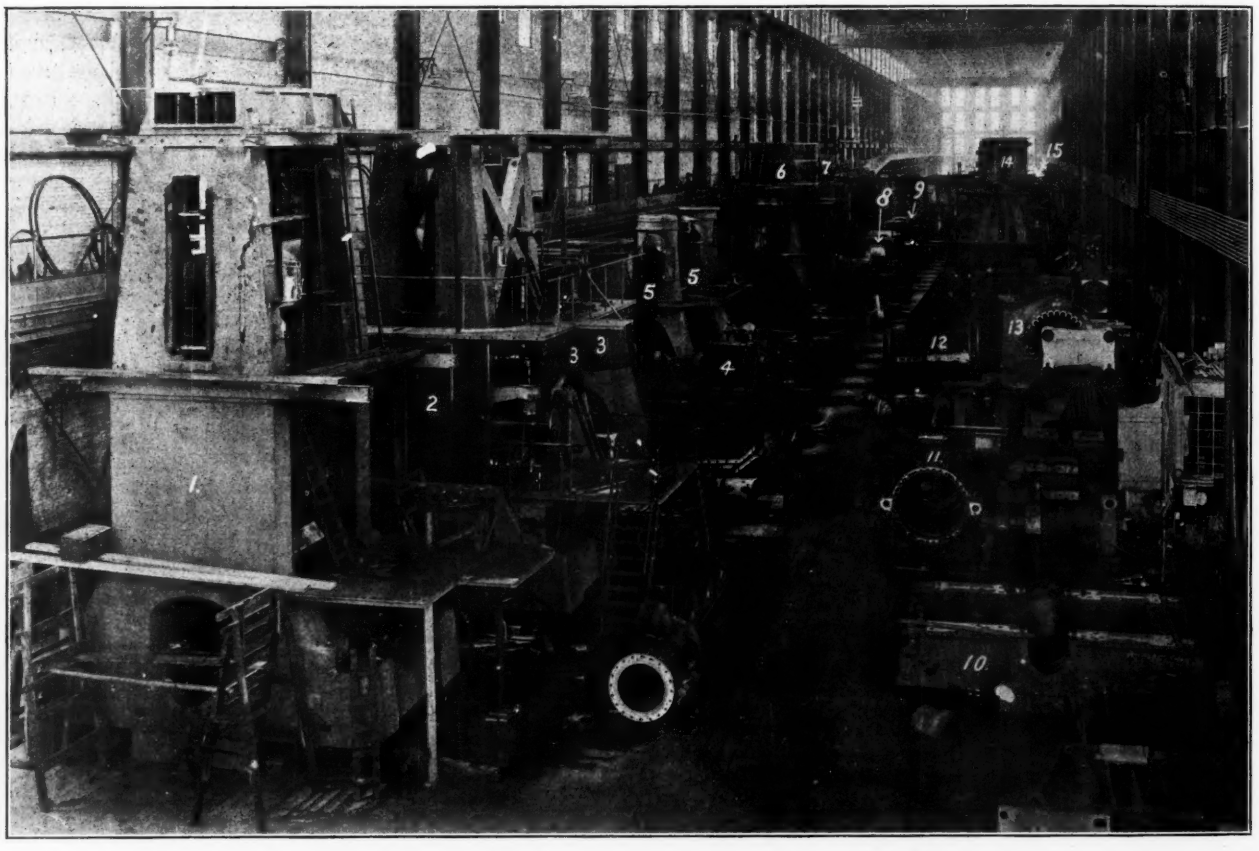
The system, as applied to electric elevators, makes use of this safety circuit to close the switch which supplies power to the motor, which is done by means of a solenoid which operates a switch placed at any convenient point. Whenever a door is opened this controlling switch is thrown, and at once cuts off the power of the car. This motion is also made use of to shunt the motor armature through a resistance, and thus act as a brake to stop the car and prevent accidents. When applied to an electrically operated car it is not only impossible to start the car except when all doors are closed, but the mere opening of any one door will at once bring the car to a standstill. The device thus not only prevents accidents which might happen to the passengers while entering the car,



SAFETY SYSTEM FOR ELEVATORS.

but does away with accidents which would happen through the opening of any other door. It may also be employed to prevent racing of the car by the addition of a simple speed-limiting controller.

Applied to the hydraulically operated elevator, the device takes the form of a lock operated by means of a magnet, which prevents the controlling valve from being open except when all doors are closed. In this case the set of switches, as before, is arranged at each door and thus connected in the circuit of the electro-magnet. When any door is opened, the magnet releases its armature and allows the lock to fall, which engages in a slot in a disc placed upon the valve rod. This lock is released by the withdrawing of the armature whenever the current is completed by the shutting of all the doors.



ERECTING SHOP OF THE ALLIS-CHALMERS COMPANY, WEST ALLIS, MILWAUKEE.

A Busy Erecting Shop.

The view of the erecting shop of the West Allis, Milwaukee, works of the Allis-Chalmers Company, reproduced herewith, shows, it is believed, a greater number of large steam-driven units in process of erection than has ever before been assembled under a single roof. It is taken from the south end of the building in such a way that the new extension, 589 feet in length to the present shop, may be seen beyond the temporary partition which marks the north boundary of the older structure.

The entire building is 1,155 feet long, 113 feet wide and 72.5 feet high to the roof trusses. The figures shown in the view, and which correspond with the following list, will furnish some idea of the magnitude of most of the engines which are being erected there. They are:

No. 1 and No. 2. Two vertical long crosshead-type blowing engines for the Republic Iron and Steel Company, fifty-two-inch and ninety-six-inch cylinders by ninety-six-inch stroke, with a capacity of 45,000 cubic feet of free air per minute.

No. 3. A vertical steeple cross-compound blowing engine, ordered by the Jones & Laughlin Steel Company.

No. 4. Steam ends of two horizontal cross-compound, vertical shaft centrifugal pumps for the Lawrence avenue station of the city of Chicago.

No. 5. A Reynolds vertical cross-compound engine, thirty-four-inch by seventy-two-inch by sixty-inch stroke for direct-connection to a 2,000-kilowatt generator, being built for the Memphis Street Railway Company, Memphis, Tenn.

No. 6 and No. 7. Two vertical cross-compound Reynolds-Corliss engines, aggregating 2,700 indicated horse-power, for the Hecker-Jones-Jewell Milling Company, whose new plant equipped with Allis-Chalmers milling machinery will be among the largest in the world.

No. 8. One of four horizontal, non-condensing air compressors, for the Buffalo-Susquehanna Coal and Coke Company, each having steam cylinders twenty-six inches by forty-four inches in diameter and air cylinders forty-two inches and twenty-six inches by forty-eight-inch strokes; capacity, 5,000 cubic feet.

No. 9. A double-drum duplex, direct-acting Corliss hoisting engine for the Shattuck-Arizona Mining Company and designed to carry continuously an unbalanced load of 15,000 pounds at a speed of 2,000 feet per minute.

No. 10. A blowing engine bed for one of several heavy furnace-blowing engines recently ordered by the Carnegie Steel Company.

No. 11. The high-pressure cylinder for one of seven pairs of vertical long crosshead-type, furnace-blowing engines, or-

dered by the Edgar Thompson Steel Works; steam cylinder forty-four-inch by sixty-inch stroke and air cylinder eighty-four-inch by sixty-inch stroke.

No. 12. Vertical slide for heavy-blowing engine, being built for the Carnegie Steel Company, Carrie furnaces.

No. 13. The famous 105-ton single casting, the largest ever poured by the Allis-Chalmers Company, for the frame and slide of a rolling mill engine to be installed at the Sharon, Pa., plant of the Carnegie Steel Company.

No. 14. Two of the Gillespie pumping engines, with a capacity of 30,000,000 gallons per twenty-four hours, for the city of Pittsburg filtration plant.

In addition to the heavy units visible in the picture, there are a number of others which are hidden from view, including a triple-expansion vertical pumping engine for the Newport Water Works.

The addition to the erecting shop will be in readiness for use within a few weeks' time, as will also the added machine-shop units No. 4, No. 5 and No. 6, which open into the extended portion of the building.

Watertight Telephone System for Battleships.

The following description and illustrations relate to the special telephone system designed and built by the Holtzer-Cabot Electric Company, Boston, Mass., for the naval department of the United States Government. Five similar systems were purchased by the government and installed upon the following battleships: California, South Dakota, Milwaukee, Indiana and Connecticut. To meet the special severe conditions which obtain on shipboard there were incorporated a number of novel and original features.

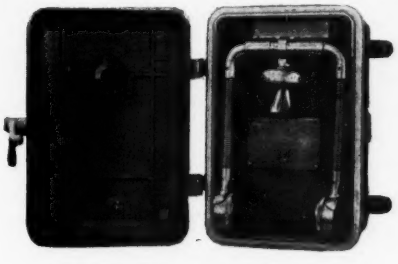


FIG. 1.—WATERTIGHT STATION.

It was especially desired that the instruments be unaffected by the action of the air, the movement of the vessel, or the concussion of the heavy guns, and the switchboard and exposed stations were to be absolutely watertight.

Fig. 1 represents one of the watertight stations. The operating parts are mounted on a frame plate which can be readily removed from the case without the use of tools and without disturbing any of the connections. One of the distinctive and original features of this station is the double receiver, the two receivers operating independently of each other, so that either or both may be used. The act of raising one of them to the ear brings the transmitter into the proper position for talking and signals the switchboard. When released all parts return to their normal condition, making it impossible for any user to leave the telephone connected to the line. The receivers are of the watchcase type, double pole, with metal cases, the coils being specially treated to make them waterproof. The transmitters are of the solid back type, the chamber being hermetically sealed, there being used nothing that will be affected by the moisture. The arms will support a weight of 200 pounds. The case which encloses the station is of composition, polished and oxidized and provided with a channel into which is fitted a molded gasket of pure rubber.

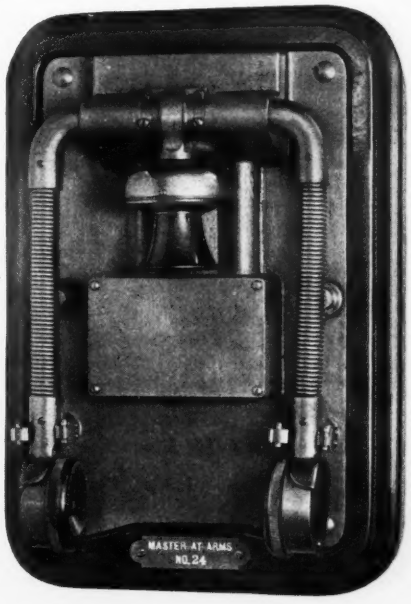


FIG. 2.—NON-WATERTIGHT STATION.

The non-watertight stations (Fig. 2) are interchangeable with the watertight telephones, the operative parts being mounted upon a mahogany base instead of in a metallic case.

With each station there is furnished a separate watertight vibrating call-bell. The design of the mechanism of this bell is distinctly special the blow being delivered to the gong through a phosphor bronze diaphragm, which is reenforced so that there is no danger of its being worn through by use. The parts of the bell are made of non-oxidizable metal with the exception of the iron and steel parts which are copper-plated and lacquered to prevent corrosion.

The operative parts of the switchboard are mounted in a heavy brass case, shown in Fig. 3. This is gasketed so that when the cover is closed it is absolutely watertight. The case is divided into two compartments, the upper containing the terminals and the lower the switchboard proper. The upper part of the case is drilled for two-inch conduits. The terminals are of heavy copper lugs and are insulated with mica. A distinguishing feature of the board is that the connections are made without cords, there being used specially designed keys instead. The front of the switchboard is subdivided into vertical strips, each holding four keys. By taking out two screws any one of these strips may be removed, exposing for examination every contact and connection on the strip. The whole front, which supports the case and signals, is hinged at the bottom so that it may be readily let down, allowing the cables to be examined. A supervisory signal is provided with each connecting circuit, the purpose of which is to indicate when the conversation has been finished.

Provision is made for connection with shore exchanges, the signaling current being obtained from a hand-power generator which is held in the box shown at the right of the cut. The system will work in connection with either a common battery or magneto exchange.

FIG. 3.—SWITCHBOARD ARRANGEMENTS.

Current for the transmitters is taken from a Holtzer-Cabot motor-generator of the noiseless type. These circuits draw their current directly from the motor-generator, there being no storage batteries. The ringing current is obtained from the ship's ringing dynamotor or, in case of disability, from an emergency set of dry batteries. The system

operates on a three-wire circuit, and five conversations can take place at the same time, or any number of stations can be connected and an order transmitted simultaneously to them from any other station.

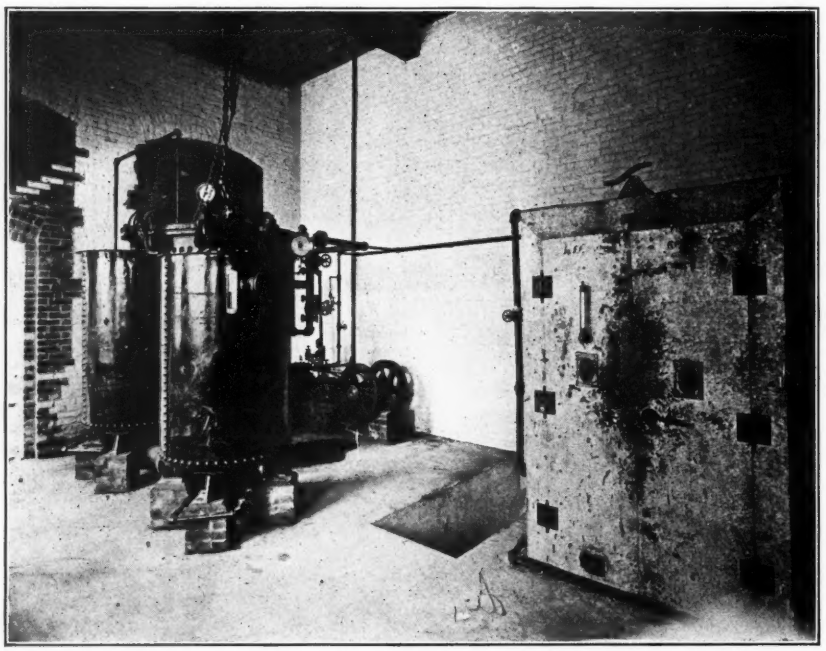
The system as a whole has been built with a special view to ruggedness, so that nothing short of actual violence can cause injury.

Applying the Vacuum Impregnating Method with "Voltax."

One of the most interesting developments during the past year in the electrical world has been the recognition of the value of the vacuum impregnating process for field and armature windings. The Electric Cable Company, of New York, after carefully investigating the claims made for this method, has adopted the Passburg system, using its well-known "voltax" as the impregnating compound. The outfit now installed in the company's works at Bridgeport, Ct., was furnished by the J. P. Devine Company, of Buffalo, N. Y., which controls the Passburg patents in this country. The apparatus consists of two wrought-iron airtight tanks, one of these being for the vacuum chamber compound. The coils to be impregnated are placed in the vacuum tank, after which a combined vacuum and air pump exhausts the air from the vacuum tank as well as any moisture present in the material composing the coils. This moisture passes through a condensing apparatus and is drained off as water. As soon as the best possible vacuum has been secured the pump is reversed to force air under pressure into the tank full of "voltax." This air naturally displaces the compound, which is forced into the vacuum chamber, where it impregnates the coils placed therein. The measuring devices used in this connection comprise an observation glass in the vacuum chamber to see the amount of "voltax" present, a thermometer for showing the temperature of the compound and a gauge to indicate both the vacuum and air pressures.

The coils are kept under vacuum condition for two hours or more, according to the windings, and under air pressure for about half as long. After this the original air pressure is greatly reduced, the connecting valve between the tanks opened and the compound forced back to the liquid tank. The valve is then closed and the coils are left to drip in the vacuum tank for half an hour or so.

It will be seen from the foregoing description that the proper carrying out of this vacuum process results in much longer life for the coils than the old dipping and baking methods. Since the coils are impregnated practically solid, wire slipping is obviated, and the elimination of entrained air and moisture gives the best condition for uniform heat radiation and the prevention of short-circuits. The fact that the impregnating compound enters the vacuum chamber without breaking the vacuum eliminates all possibility of the dried coils absorbing moisture.



VACUUM IMPREGNATING AND DRYING APPARATUS.

Steam Turbine Installations.

The Delaware, Lackawanna & Western Railroad Company has contracted with the Westinghouse Machine Company for two Westinghouse-Parsons steam turbines to be installed in its passenger terminal at Hoboken, N. J. The turbines will operate under a steam pressure of 140 pounds, twenty-eight-inch vacuum, and moderate superheat, driving 500-kilowatt, three-phase, sixty-cycle Westinghouse generators of the rotating-field enclosed turbo type. These machines will supply current to the station and yards. Internal superheaters will be used, while the condensing system will be Worthington barometric. Babcock & Wilcox boilers will supply steam, using small anthracite coal.

The Navy Department in its recent power extensions to the New York navy yard has, through its Bureau of Yards and Docks, adopted Westinghouse-Parsons steam turbines, which will be installed in building No. 41.

The present installation will comprise two 500-kilowatt units operating under 150 pounds steam pressure, twenty-eight-inch vacuum and on superheated steam at 100 degrees Fahrenheit. The power plant supplies three-phase alternating current at 2,300 volts, and sixty-cycle frequency, to machine shops, dry docks, and other general purposes about the New York yards, including lighting of buildings. The contract for these turbines was secured on rigid government specifications and under strong competition. Boilers will be of the Stirling water-tube type, with Foster internal superheaters. Worthington surface condensers will be used. This will make the second turbine plant that the Westinghouse Machine Company has installed for the Navy Department, the first one being at the Boston navy yard, where the turbines have been giving very good service.

The Burlington municipal lighting plant at Burlington, Vt., has recently contracted with the Westinghouse Machine Company for a Westinghouse-Parsons turbo-generator unit. The turbine will be direct-connected to a three-phase, 2,300-volt, sixty-cycle turbo-alternator, running at 3,600 revolutions per minute, and will operate on 150 pounds of steam with twenty-eight-inch vacuum.

Stockholders of the Allis-Chalmers Company at a special meeting, held at Jersey City, N. J., July 16, voted to authorize an issue of bonds to the amount of $15,000,000.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

POWER COMPANY SOLD TO SYNDICATE—Announcement is made of the purchase of the Bar Harbor & Union River Power Company by a syndicate of New York and Philadelphia capitalists, of which John R. Graham, of Bangor, Me., is the head. The men interested are the owners and principal stockholders of the Bangor Railway and Electric Company, the Lewiston, Brunswick & Bath Railway and other enterprises in the state. The amount of capital involved in the transfer is said to be about $700,000.

MEMPHIS TELEPHONE COMPANY TO INCREASE CAPITAL STOCK—The Memphis Telephone Company purposes increasing its capital stock from $1,000,000 to $3,000,000, and to this end has filed a $3,000,000 mortgage. The proceeds of the bond issue will be devoted to the improvement and expansion of the system. The first work will be done in the present home of the company and will include the installation of new machinery. Later the company plans to establish another exchange in the eastern part of the city.

NORTHERN OHIO TRACTION AND LIGHT—The plan under which the Northern Ohio Traction and Light Company will acquire the properties of the Tucker Anthony syndicate in northeastern Ohio has been perfected. It will become operative in about sixty days, or as soon as the legal requirements are complied with. The capital of the Northern Ohio company will be increased from $7,500,000 to $10,000,000, while the preferred stock of the Canton-Akron line will be transferred for six per cent divisional lien mortgage bonds, and the common stock for Northern Ohio stock at par. For the other lines an exchange of stock has also been arranged. This merger will result in a system operating 202 miles.

NEW RAILWAY AND LIGHTING COMPANY—The American Cities' Railway and Light Company has been incorporated at Trenton, N. J., with a nominal capital of $15,000, which will be increased to $27,500,000, divided into $12,500,000 cumulative preferred and $15,000,000 common stock. The new corporation is to take over the Birmingham Railway, Light and Power Company, the Memphis Street Railway, the Nashville Railway and Light Company, the Little Rock Railway and Electric Company, the Knoxville Railway and Light Company and the Houston Lighting and Power Company. In exchange for the stock of these six companies the American Cities' Railway and Light Company will issue its entire common stock and $10,000,000 of its preferred stock, reserving $2,500,000 of the latter for future uses.

ELY SYNDICATE PURCHASES OHIO TROLLEY LINES—The transfer of the Steubenville Traction and Light Company, of Steubenville, Ohio, to the Ely syndicate, of Buffalo, N. Y., by the Ohio Valley Finance Company, an underlying company of the American Gas Company, of Philadelphia, has been perfected. The syndicate is concluding the purchase of lines at East Liverpool, Toronto and other Ohio river points, and proposes to build a line down the Ohio river from Pittsburg, Pa., ultimately to Cincinnati. Van Horn W. Ely was made president of the Steubenville company, succeeding J. Charles Ross. The Steubenville Traction and Light Company was organized in 1901 to merge the Steubenville Traction Company and the Steubenville Gas and Electric Company. It also owns the Steubenville & Pleasant Heights road and controls the Steubenville & Toronto Traction Company. The company has an authorized capital stock of $1,000,000, all of which is outstanding. The funded debt consists of $1,000,000 first mortgage five per cent bonds, of which $790,000 are outstanding, the rest being reserved for extensions and improvements.

LARGE ELECTRIC MERGER—The merger projected by the Clark, Pratt and Seligman interests has been consummated in the organization of the Portland Railway, Light and Power Company, which has taken over the Portland Railway Company, Portland General Electric Company, Oregon Water Power and Railway Company, Citizens' Light and Traction Company, of Salem; Vancouver Electric Light Company and the Union Light and Power Company, operating plants at Woodburn, Silverton and Mount Angel. The company is capitalized at $15,000,000, of which $5,000,000 is preferred stock and $10,000,000 common. Its principal place of business will be at Portland, Ore. Officers have been elected as follows: H. W. Goode, president of the Portland General Electric Company, president; F. I. Fuller, president and general manager of the Portland Railway Company, vice-president; H. L. Clark, of the banking house of E. W. Clark & Company, of Philadelphia, vice-president; S. G. Reed, treasurer Portland Railway Company, treasurer; C. N. Huggins, secretary Portland Railway Company, secretary. The board of directors includes C. M. Clark and H. L. Clark, of Philadelphia; Frederick Strauss, of Seligman & Company, New York; A. C. Bedford, of Charles M. Pratt & Company, New York; H. W. Goode, F. I. Fuller, O. F. Paxton, S. G. Reed and F. G. Sykes, of Portland. The executive committee is made up of C. M. Clark, Frederick Strauss, A. C. Bedford and H. W. Goode. The company plans to expend $2,500,000 in improving and extending its system.

EDUCATIONAL.

POLYTECHNIC INSTITUTE OF BROOKLYN—The fifty-seventh annual catalogue of the Polytechnic Institute of Brooklyn (N. Y.) has been issued. It contains descriptions of the various courses offered at that institution.

UNIVERSITY OF WISCONSIN—The graduating class in electrical engineering of the University of Wisconsin consisted of forty-four men, who, it is announced, have all obtained good positions; in fact, all of them had been retained by some company before receiving their degrees.

UNIVERSITY OF UTAH—The University of Utah has issued its annual catalogue for the School of Arts and Sciences, the State School of Mines and the State Normal School. This gives a description of the work of the different schools and of the courses of instruction offered there.

NEW PUBLICATIONS.

VERIFICATION OF STANDARDS OF MASS—The Bureau of Standards, of the Department of Commerce and Labor, Washington, D. C., gives, in circuiar No. 3, a description of the work which can be done there at the present time in verifying the standards of mass. This circular describes the present standards, the secondary standards and the classification used in verifying weights. Instructions are given for submitting weights for test.

CANADIAN SELECT COMMITTEE ON TELEPHONE SYSTEMS—Vol. i of the proceedings of the select committee on telephone systems appointed by the Canadian government to investigate the various public telephone systems in operation in Canada and elsewhere has been received. This contains the minutes of the committee's proceedings, minutes of evidence taken, the engineering reports and a synopsis of the exhibits and indices to the different sections of the report.

RAILWAY SIGNAL ASSOCIATION—The Railway Signal Association has issued a digest of the proceedings of the association, formerly known as the Railway Signaling Club, which covers the meetings held during the ten years, 1895 to 1905. This book, which is designated as vol. i of the revised edition, relates the formation of the Railway Signaling Club and describes its growth until the association was formed. The volume includes a large number of interesting papers on railway subjects and the discussions which followed their presentation. It contains 544 pages.

NEW INCORPORATIONS.

JACKSON, MICH.—Rives Telephone Company. $1,000.

LANSING, MICH.—Fenwick Telephone Company, Palo. $8,000.

LINCOLN, ILL.—Elkhart Independent Telephone Company. $1,250.

SCRANTON, PA.—Wagner Telephone Company, Dyberry township. $3,000.

LINCOLN, NEB.—City Mutual Telephone Company. Capital increased to $25,000.

DOVER, DEL.—Clayton, Smyrna & Bayshore Traction Company, Philadelphia. $6,000.

LANSING, MICH.—Arenac, Ogemaw & Iosco County Telephone Company, England's Corners. $1,000.

SPRINGFIELD, ILL.—Citizens' Telephone and Telegraph Company, Carlyle, Clinton county. $15,000.

CLEVELAND, OHIO—United States Telephone Company, Cleveland. Increase of capital from $2,500,000 to $4,500,000.

AUSTIN, TEX.—Delta Telephone Company, Cooper, Delta county. $15,000. Incorporators: C. H. Reid, R. M. Connell and R. M. Walker.

JEFFERSON CITY, MO.—Sarcoxie Telephone Company. $5,000. Incorporators: H. B. Boyd, Harry Bean, B. W. Alley and B. Pile.

ST. JOHN, NEW BRUNSWICK—Maritime Light and Power Company. $100,000. Incorporators: James Russell Starr and James H. Spence.

LANSING, MICH.—The Northern Light and Power Company. To develop the water power of the Flint river, in Montrose township. $625,000.

LINCOLN, NEB.—The Chadron Telephone Company, of Chadron. $25,000. Directors: Joseph T. May, Adolph W. Riekman and Louis E. May.

SPRINGFIELD, ILL.—Kavanaugh Telephone Company, Effingham. $30,000. Incorporators: H. H. Kavanaugh, P. N. H. Munson, M. P. Turner.

IDAHO FALLS, IDA.—The Cedar Point Power and Light Company, Limited. To build a power-house at a point on the Snake river. $25,000.

SPRINGFIELD, ILL.—Strasburg Mutual Telephone Company, Strasburg. $10,000. Incorporators: J. F. Kull, Martin Hamm and L. J. Kirchner.

MINNEAPOLIS, MINN.—Town and Country Telephone Company, Dawson. $50,000. Incorporators: Albert Ewing, Peter Bergh, Andrew Grande, Dawson.

SPRINGFIELD, ILL.—Heyworth Telephone Company, Heyworth. $10,000. Incorporators: Henry E. Hitchhorn, H. Dale Cline and Charles Hitchhorn.

COLUMBUS, OHIO—Farmers' Telephone Company, Cadiz. $1,000. Incorporators: A. M. McCombs, James Love, J. M. Megaw, S. E. Adams and Lewis M. Peck.

HOLT, MO.—Clay county Telephone Company, Holt. $50,000. Incorporators: William H. Smith, John A. Eby, George W. Sexton, E. T. Hockaday and others.

ST. PAUL, MINN.—National District Telegraph Company. $50,000. Incorporators: Albert D. Bradley, James Swan, of Minneapolis, and John McRobie, of Chicago.

INDIANAPOLIS, IND.—Advance Telephone Company, Vanderburg county. $650. Directors: Henry Denzer, Henry Hartig, Charles Bocke, Fred Werkman and C. Siefert.

COLUMBUS, OHIO—The Poland, Boardman & Canfield Railway Company, of Youngstown. To construct an electric line connecting the cities named in the title. $10,000.

GUTHRIE, OKLA.—The Day County Telephone Company, Grand. $5,000. Incorporators: J. P. Johnson, E. S. Sharp, E. L. Mitchell, W. H. Hauser, S. Crim, Jr., and T. C. Moore.

COLUMBUS, OHIO—The Old Fort Mutual Telephone Company, Seneca county. $10,000. Incorporators: R. G. Shannon, H. S. Fry, C. J. Fry, N. S. Beck and G. E. Zimmerman.

COLUMBUS, OHIO—Mile Run Mutual Telephone Company, Marietta, Ohio. $2,500. Incorporators: William F. Watkins, Leonard F. Winn, Jessie Thomas, Roger Fish and John S. Wynn.

TOLEDO, OHIO—Toledo, Defiance & Fort Wayne Railroad Company, Toledo. $10,000. Incorporators: E. B. Paxton, James H. Horan, G. L. Shanks, Frank G. Crane and D. L. Stine.

YOUNGSTOWN, OHIO—Cleveland, Youngstown & Eastern Railway. $10,000. Incorporators: Alonzo M. Snyder, H. Park Ford, A. A. McCaslin, H. Melvin Roberts and Elmer G. Derr.

COLUMBUS, OHIO—The Home Telephone Company, Ironton. $50,000. Incorporators: Robert A. Knapp, E. W. Bixby, S. P. Humphrey, B. F. Forgey, J. C. Snyder and A. J. Lathouse.

DENVER, COL.—The Cherryvale Electric Light and Power Company. $25,000. Incorporators: Hugh E. West, W. R. Murrow, Seth H. Piper, Charles T. Fertig, E. A. Sunderlin, Colorado Springs.

SPRINGFIELD, ILL.—Peoria, Streator & Ottawa Railway Company. To run from Ottawa and Streator through Eureka and Washington and connect with the Peoria & Bloomington line at Morton. $100,000.

LINCOLN, NEB.—The Martel Farmers' Independent Telephone Company. $500. Officers: Albert Egger, president; John A. Sittler, vice-president; William H. H. Moore, secretary; Edward Bohmont, treasurer.

BELLEVILLE, ILL.—Risdon Telephone Company, of Lenzburg. Incorporators: Dan Waeltz, Adam Kirchhoefer, Henry Kirchhoefer, Fred W. Wasem, Henry Gruenewald, Herman Kirchhoefer and George Waeltz, Jr.

GUTHRIE, OKLA.—The Farmers' Mutual Telephone Company, of Rossville, Lincoln county. $2,000. Directors: C. A. Taft and D. Keer, of Meeker; W. G. Hall and T. A. Ward, of Rossville, and L. J. Harden, of Middlothian.

LOIS, VA.—Lois Mutual Telephone Company. $5,000. Incorporators: J. M. Price, president; J. E. Stively, vice-president, both of Bealeton, Va.; George E. Bain, secretary and treasurer; R. W. Kemper and L. M. Anns, all of Lois.

MILWAUKEE, WIS.—The Tri-State Telephone and Telegraph Company, Augusta, Me.; western headquarters at Minneapolis. $2,000,000, of which $10,000 is represented by property and business in Wisconsin. E. H. Moulton, president, and F. C. Nelson, secretary.

NASHVILLE, TENN.—Jackson Railway and Light Company, Madison county. To construct an electric railway in the city of Jackson and also in the county of Madison. $600,000. Incorporators: S. S. Bush, Attilla Cox, Alan McDonald, John Wisdom and Charles D. Lehmkuhl.

INDIANAPOLIS, IND.—Citizens' Automatic Telephone Company. To operate automatic telephone systems in the counties of Miami, Howard, Wabash, Fulton, Cass, Carroll, Clinton, Tipton, Madison, Delaware, Blackford, Wells, Huntington, Whitley, Kosciusko and Marshall. $300,000.

CINCINNATI, OHIO—The Jesse T. Sheets Telephone Company. To operate a telephone exchange in Cincinnati, Covington and Newport and in Kenton, Campbell and Pendleton counties, Ky. $10,000. Incorporators: Jessie T. Sheets, Katie Sheets, Horace and Theodore Horstman and Adelaide Ament.

RICHMOND, VA.—Caroline County Telephone Company, of Bowling Green, Va. $10,000. Officers: C. T. Smith, president, Croxtons, Va.; W. E. Innes, vice-president, N. T. McManaway, secretary; L. E. Martin, treasurer, Bowling Green; directors, S. E. Pitts, Sparta, Va.; C. M. Harris, Whites, Va.; G. P. Lyons, Woodfords, Va.

SPRINGFIELD, ILL.—Lee County Railway Company. To be constructed from Nachusa, Lee county, Ill., westerly to connect with the Chicago & Northwestern Railway, thirteen miles. $10,000. Incorporators and first board of directors: Marvin Hughitt, J. M. Whitman and J. B. Redfield, Chicago; W. A. Gardner, Evanston; H. R. McCullough, Lake Forest.

SPRINGFIELD, ILL.—Hammond Belt Railway Company. To be constructed from Hammond, Ind., northwesterly and northerly to a point near intersection of railroads in Calumet Park, Cook county, Ill. $75,000. Incorporators and first board of directors: Worth E. Caylor, Frank P. Schmitt, William G. Wise, Wallace A. Walker, Chicago; Hezekiah L. Jackson, Hammond, Ill.

PERSONAL MENTION.

MR. PAUL J. KRUESI, of Chattanooga, Tenn., and Miss Myra Kennedy Smart will be married on Thursday, July 26. Mr. and Mrs. Kruesi will be at home after the first of October at Riverview, Chattanooga, Tenn.

MR. ALTON D. ADAMS, electrical engineer, Worcester, Mass., is appraising the value of the property of the two electric lighting companies at Watertown, N. Y., preparatory to making a report to the city authorities, who contemplate buying the plants.

MR. GEORGE CAMPBELL, president of the Germania Electric Lamp Company, Harrison, N. J., returned recently on the Lucania from Liverpool, where he has been for thirty days in connection with the company's export business, of which Mr. Campbell reports a material development.

MR. WILLIAM M. MARINAN, for twelve years in the employ of the Elmira (N. Y.) Water, Light and Railroad Company, has been appointed general superintendent of the Dunkirk, Fredonia & Brockton Electric Light, Gas and Street Railway Company, with headquarters at Fredonia, N. Y.

MR. ALPHA H. KLING has withdrawn from the Peru Electric Manufacturing Company, Peru, Ind., with which he has been sales manager for some time. Mr. Kling will act as manufacturers' sales agent, and will represent in the central states a number of leading manufacturers, with headquarters at Peru. He will carry a very complete line of electrical supplies.

MR. W. C. WOODWARD, electrical engineer of the Narragansett Electric Light Company, was a New York visitor last week, and while here was the guest of honor at a luncheon at the Hardware Club. A number of electrical men, prominent in various branches of the industry, welcomed Mr. Woodward to the city and congratulated him over the great success of his company.

MR. CLARENCE H. MACKAY, president of the Postal Telegraph-Cable Company, and his mother, Mrs. John W. Mackay, have donated $100,000 to the University of California for the establishment of a professorship of electrical engineering. This bountiful gift is in honor of the memory of Mr. Mackay's deceased brother, Mr. John W. Mackay, Jr. Professor C. L. Cory will be at the head of the department of electrical engineering.

MR. HENRY L. DOHERTY, president of the Denver Gas and Electric Company, has opened a "school of practice," in which twenty young men who have just graduated from the engineering departments of various colleges and universities of the country will receive practical instruction in all branches of the gas and electric business. The course, as outlined by Mr. Doherty, will cover two years, and will carry the students through all departments of the Denver Gas and Electric Company.

MR. H. W. TURNER has associated himself with Mr. H. M. Hobart, consulting engineer, London, England. He will be engaged in advising with regard to manufacturing methods, machinery and shop organization, and other work connected with the manufacture of dynamoelectric machinery. Mr. Turner has had an experience of over twenty years with British, Continental and American companies, having been with the British Thomson-Houston and the British Westinghouse companies three and one-half years, with the Union Elektricitäts Gesellschaft, Berlin and Vienna, for eleven years, and with the Thomson-Houston Company, Lynn, Mass., for nine years. In taking up his new work he leaves the British Westinghouse Company, where he has just completed a two-year engagement.

LEGAL NOTE.

DIVIDED-POLE FIELD-WINDING CASE—In the case of the Emerson Electric Manufacturing Company *versus* the Century Electric Company, both of St. Louis, Mo., heard before Judge Finkelnburg in the United States Circuit Court for the Eastern Division of the Eastern Judicial District of Missouri, a decree was entered on July 9 in favor of the complainant with reference to a master of the court for an accounting. This case was a suit for infringement of patent No. 583,933, dated June 8, 1897, and especially of claim five of this patent, covering the "pyramidal" or divided form of field winding.

ELECTRICAL SECURITIES.

The market last week was dull and irregular, with prices sagging in the main. Dealings were almost wholly professional, and while there was some public liquidation, this was probably offset by an equal amount of outside buying. The crop reports continue to be reassuring, and the only apprehension in this direction is the possibility of monetary stringency during the crop-moving period to come later. The copper situation still shows an unexplained weakness, and in some quarters there is discouraging comment concerning the iron and steel industry, although it is quite likely that the United States steel report for the quarter ending in June will show record figures.

ELECTRICAL SECURITIES FOR WEEK ENDING JULY 14.

New York:	*Closing.*
Allis-Chalmers common	16¾
Allis-Chalmers preferred	46¾
Brooklyn Rapid Transit	72½
Consolidated Gas	136½
General Electric	161
Interborough-Metropolitan common	36
Interborough-Metropolitan preferred	74
Kings County Electric	165
Mackay Companies (Postal Telegraph and Cables) common	71
Mackay Companies (Postal Telegraph and Cables) preferred	71¾
Manhattan Elevated	147
Metropolitan Street Railway	102¾
New York & New Jersey Telephone	125
Western Union	91
Westinghouse Manufacturing Company	152

The pamphlet report of the Brooklyn Rapid Transit Company for the fiscal year to June 30 is in course of preparation, but will not appear until about the middle of August, or later. The company usually publishes its report about six weeks after the close of the fiscal year.

Boston:	*Closing.*
American Telephone and Telegraph	129
Edison Electric Illuminating	240
Massachusetts Electric	68
New England Telephone	130
Western Telephone and Telegraph preferred	90

Philadelphia:	*Closing.*
Electric Company of America	11½
Electric Storage Battery common	67
Electric Storage Battery preferred	67
Philadelphia Electric	7⅞
Philadelphia Rapid Transit	29¼
United Gas Improvement	82

The directors of the Electric Company of America have declared the regular semi-annual dividend of 3½ per cent to stock of record July 20.

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	135
Metropolitan Elevated preferred	66
National Carbon common	81¾
National Carbon preferred	117
Union Traction common	4
Union Traction preferred	14

The regular quarterly dividend of 2 per cent on Chicago Edison is payable August 1. Books close July 21 and reopen August 2.

For the half year ended June 30 the Chicago elevated roads carried 65,830,000 passengers, the increase being 7.12 per cent, rather above the normal gain.

OBITUARY NOTICE.

F. T. FOXENBERGER, who had been with the Bossert Electric Construction Company, of Utica, N. Y., died on the afternoon of Thursday, July 12, as the result of an operation. Mr. Foxenberger was widely and pleasantly known throughout the electrical industry, especially among the contractors and manufacturing branches, and his death at such an early age (he was under thirty) will cause much regret. Some two months ago he underwent an operation which was not successful, and this later one, from which he died, was deemed necessary, although the surgeons realized the small probability of saving his life.

ELECTRIC RAILWAYS.

MARYSVILLE, CAL.—Grading has been commenced on the extension of the Northern Electric road to Sacramento.

ELLOREE, S. C.—There is a plan on foot to build an electric line from Elloree *via* Parlers to Pinckney's Landing, a distance of seven miles.

MORGANTOWN, W. VA.—The South Morgantown Traction Company has let the contract for grading its right of way. The company expects to have cars running by September 1.

DELPHI, IND.—The construction of the Lafayette & Logansport Traction line has been begun near Delphi. The builders hope to have the line completed and cars running by the first of next year.

BROCKPORT, N. Y.—The Brockport village board of trustees has granted a franchise to the Buffalo, Lockport & Rochester Electric Railroad Company to extend its lines through Brockport streets.

MUNCIE, IND.—The Muncie & Union City Traction Company has been incorporated at Indianapolis with a capital of $500,000 to build a line between Selma, Parker City, Farmland, Winchester and Muncie. The road will parallel the "Big Four."

CHICAGO, ILL.—The sale of the Calumet Electric Street Railroad Company, to a syndicate headed by Cobe & McKinnon, has been confirmed. This was one of the assets of the National Bank, of Illinois, the receivership of which will shortly be terminated.

COLUMBUS, GA.—The work of constructing the Atlanta, Birmingham & Atlantic Railway from Warm Springs to Atlanta, a distance of seventy miles, begins soon, the contract having been let to the Callahan Construction Company, of Knoxville, Tenn.

COLUMBUS, GA.—The movement to build an electric railroad from Columbus to Dothan, Ala., and thence to St. Andrews Bay, Fla., is taking shape, a large number of the business men of Columbus having signed an agreement to heartily support the project.

AUSTIN, TEX.—E. M. House, of Austin, is arranging with Stone & Webster, Boston, Mass., for the building of an interurban electric railway between Houston and Galveston. It is stated that the negotiations for building the line have been closed. It will be fifty-one miles long.

ASHLAND, OHIO—Officials of the Cleveland, Ashland & Mansfield Railway Company have arranged for building the Ashland & Mansfield end, and to give service between these points by January 1. The line will then be extended north to North Fairfield, connecting with the Lake Shore Electric.

CLEVELAND, OHIO—The Columbus, Delaware & Marion Traction Company is now engaged on the construction of an extension from Marion, the present northern terminus, to Bucyrus, where connection will be made with the Ohio Central. It is understood that this line will be completed by the fall.

TORONTO, OHIO—The ordinance granting a franchise to the Steubenville Traction and Light Company, for the construction of a second track through the city of Toronto, and the extension of the present franchise for a term of twenty-five years, has been passed unanimously by the city council.

WILMINGTON, DEL.—An ordinance has been passed by the town council of Newark, giving permission to the Delaware Interurban Railway Company to lay tracks on Main and Elkton streets in that town. The granting of the franchise was made conditional upon the depositing of $2,000 by the company within thirty days.

SHARON, PA.—The Shenango-Midland Street Railway Company has accepted the franchise ordinance passed by the Sharon council. The company has five months to begin work on the line in Sharon, at which time it must pay the city $2,500 and ten months after another $2,500. This is part of the line which will extend to New Castle.

ALBUQUERQUE, N. M.—Frank G. Caldwell, American representative of a foreign corporation, interested in building an electric line from Hillsboro mining camp, thirty-six miles to Osceola, on the Santa Fe railroad, states that the road will be built, construction to commence shortly after his return to New York to make final report on the project. The proposed electric road will facilitate mining operations in that district greatly.

WINSTED, CT.—The New York, New Haven & Hartford Railroad has acquired three-quarters of the Torrington & Winchester Street Railway, running from Winsted to Torrington, ten miles, and will, it is reported, extend the line to Thomaston, to which place the trolley is to be extended from Waterbury. It is generally believed that the New York & New Haven road will eventually build a trolley line connecting Winsted and Canaan, to which place it is to extend its Berkshire trolley line from Great Barrington, Mass.

SPOKANE, WASH.—The British Columbia Electric Railway Company has decided to construct an electric line from New Westminster to Port Moody and from Port Moody to Vancouver, which will make an alternate route to that now in operation between Vancouver and New Westminster direct. The direct road is only twelve miles long, but the new line, about eighteen miles, will take in the small places along Burrard inlet as far as Port Moody and then turn west toward New Westminster, taking in the new town of Millside.

CINCINNATI, OHIO—The Hillsboro, Belfast & Peebles Traction Company has been organized by a number of citizens of those towns, for the purpose of building an electric road from Hillsboro, through Belfast to Peebles, with a proposed extension to the Ohio river at Aberdeen. The officers elected are: P. M. Hughes, of Lovett, Ohio, president; J. W. Letherman, of Belfast, vice-president; W. B. Cochran, of Hillsboro, secretary. The proposed road will connect at Hillsboro with the Cincinnati & Columbus traction line, which operates from Cincinnati to Hillsboro.

ATLANTA, GA.—At a meeting of the incorporators of the new interurban electric line between Macon and Atlanta it was authorized that work on the line be begun at once. The stock subscribed was $100,000, but this will be increased from time to time. The executive committee is composed of W. J. Kincaid, of Griffin, chairman; W. J. Massee, of Macon; Colonel Clifford L. Anderson and Edwin P. Ansley, of Atlanta, and W. A. Wimbish, of Atlanta, secretary and treasurer. The line will be eighty-eight miles long, and will connect Atlanta, Forrest, Griffin, Forsyth, Macon and the intervening towns.

NEW HAVEN, CT.—The Consolidated Railway Company has authorized the survey of a line between Mount Carmel and Cheshire, a distance of about seven miles, the new line running as a double track to the Northampton steam road between the two points. This is preliminary to the electrification of that part of the Waterbury and Meriden branch which runs eight miles between Cheshire and Waterbury. When the electrification of the two roads is completed there will be a local service between New Haven and Mount Carmel, and between the latter point and Waterbury an express electric service on a line with low grades and few stops.

BOSTON, MASS.—Stone & Webster have purchased the Key West Electric Company, which does the entire electric railway and lighting business of Key West, Fla. The company will retire all the outstanding securities, and the new capitalization will be as follows: $1,000,000 first mortgage, fifty-year, five per cent bonds; $230,000 preferred, six per cent non-cumulative stock; $500,000 common stock. New money will be provided to reequip the power station, to purchase cars and equipment, to extend the lighting system, to develop the gas business under the franchise owned by the company, and to put the entire property in the best operating condition. The present street railway mileage is five miles.

MOUNT STERLING, KY.—Under the articles of incorporation of the Paris, Mount Sterling & North Middletown interurban railway, the stockholders met at Paris and elected a board of directors, as follows: John T. Collins and W. A. Thomason, of North Middletown; Judge H. Clay McKee and J. M. Bigstaff, of Mount Sterling; R. J. Neely, Robert C. Talbott and Henry A. Power, of Paris. After the election of the board of directors, the following officers were elected: Robert C. Talbott, president; John T. Collins, vice-president; Henry A. Power, treasurer, and H. Clay McKee, secretary.

TELEPHONE AND TELEGRAPH.

TUSCALOOSA, ALA.—The Postal Telegraph Company is rebuilding its line through Alabama.

MOUNT MORRIS, N. Y.—The Bell Telephone Company has installed a common battery system in Mount Morris.

PLAINFIELD, N. J.—Work has been commenced on a three-story building for the New York & New Jersey Telephone Company.

RISING SUN, MD.—Telephone lines are being erected from Blake to Lombard and from Rising Sun to Rock Springs.

ANNISTON, ALA.—The Anniston line of the Southern Bell Telephone Company has been rebuilt and put in excellent condition, and is now open for business.

GOSHEN, IND.—The Bell Telephone Company will shortly begin the work of overhauling its system in Goshen. A new board with a capacity of 1,000 lines will be installed, and 36,000 feet of cable will be strung.

FORT WAYNE, IND.—The Home Telephone Company has closed a contract with the Stromberg-Carlson Telephone Manufacturing Company for a complete new toll board. One section will be fitted up for farmers' lines.

GREENVILLE, S. C.—At a meeting of the board of trade a resolution was adopted looking toward a contract with the Southern Bell Telephone Company for installing a larger and entirely new plant in Greenville.

BUTTE, MONT.—The Rocky Mountain Bell Telephone Company is now erecting new buildings at Bozeman and Livingston, and a new wire is being constructed from Logan in order to give an additional circuit for Butte and Helena.

TROY, ALA.—The Orion Telephone Company has been organized. It will build a telephone line from Troy to Orion, Pine Level and China Grove. W. C. Starke, of Troy, was chosen president, and W. G. Chancy, of Orion, secretary and treasurer.

WILMINGTON, DEL.—The Delaware & Atlantic Telegraph and Telephone Company is arranging to put a large force of men to work to complete its conduit system in Wilmington. It is likely that the system will be completed before the end of the year.

SCHENECTADY, N. Y.—At the annual meeting of the directors of the Home Telephone Company plans were made for the extension of the system of the company in the city and the laying of all cables underground. The directors reelected the old officers, as follows: president, Charles F. Veeder; vice-president, Irving H. Griswold; secretary, F. M. Strong; treasurer, E. S. Kellogg.

GREEN ISLAND, N. Y.—At the meeting of the village trustees a franchise was granted to the Hudson River Telephone Company, allowing it to construct and maintain a system of underground wires in all of the streets, alleys and public places. According to the terms of the franchise the company will be obliged to comply with all the laws of New York state and special ordinances relating to villages.

DETROIT, MICH.—The directors of the Michigan State Telephone Company have approved the extension plans recently decided upon by the executive committee. These extensions include the erection of a large addition to the company's headquarters in Detroit, an extension of conduits that will permit the installing of something like 10,000 more telephones in Detroit and extensions of long-distance lines throughout the state.

FREDONIA, N. Y.—The Fredonia Telephone Company has its new line to Cassadaga, which will join at that place the long-distance line of the Jamestown company, nearly completed. The company will install a new exchange at Cassadaga and operate a branch system covering Lily Dale and Stockton. A large number of new telephones will be installed in the thickly settled farming community between Fredonia and Stockton.

JOPLIN, MO.—A franchise granting to the Missouri & Kansas (Bell) Telephone Company the right to construct a conduit underground system from First to Tenth street, on Main, has been passed by the Joplin city council. The franchise grants permission to construct an underground conduit for telephone wires, with suitable manholes, in exchange for which the company agrees to remove its present poles from Main street, to supply, through such conduit, free fire-alarm and police call service as may be installed by the city, to furnish the city rent free ten telephones, and to supply other additional city telephones at one-half regular service rates. The work of building the conduit is to begin at once.

ELECTRIC LIGHTING.

KENNETT, MO.—It has been voted to install an electric light plant at Kennett.

OTTAWA, KAN.—The city of Ottawa has taken over the water and electric light plants, and will begin at once to spend $80,000 in improvements.

BELLAIRE, MICH.—Bellaire has voted to borrow $2,200 to raise the dam of the municipal lighting plant and install a municipal system of waterworks.

NELSON, BRITISH COLUMBIA—A new company has been formed with a capitalization of $1,500,000 for the purpose of generating power for the supplying of light and motive power to the towns surrounding Moyie and Cranbrook, where many mines are situated.

BUFFALO, N. Y.—At a meeting of the Cataract Power and Conduit Company the following directors were elected: Edward D. Adams, John Jacob Astor, D. O. Mills, Francis Lynde Stetson, Edward A. Wickes, Charles R. Huntley, Daniel O'Day, George Urban, Jr., and DeLancey Rankine.

COLORADO SPRINGS, COL.—Plans for the erection of an electric power station, west of Green Mountain Falls, to furnish light and power to Ute Pass points, have been completed by Theophilus Harrison and F. E. Dow, who own a large water system above Green Mountain Falls, on the north slope of Pike's Peak.

ONTARIO, ORE.—The Ontario city council has granted a ten-year franchise to the Idaho Light and Power Company for an electric light system. The company will secure its power from the Payette river in Idaho, and will also supply the towns of Weiser, Payette and New Plymouth in Idaho with light. The franchise calls for the completion of the system within one year.

CLINTON, MASS.—The Boston Heat, Light and Power Company, which owns the electric and gas lighting plants in Clinton and Leominster as well as in twenty-five or thirty other towns and cities in the state of Massachusetts, it is announced, is to build a power plant for the generation of electricity at Still River Depot, in the town of Harvard. Surveys of the property to be acquired are now being made.

SWEETWATER, NEV.—Work has been begun by the New Bodie Mining Company upon the construction of a large electric generating station on the East Walker river, which is intended to supply power for the mines of Aurora, Masonic, Bodie and southern Nevada. Sufficient water has been taken up to operate a 10,000-horse-power plant. The electric station alone will cost over $150,000, according to the plans outlined.

WILMINGTON, DEL.—The Delmarvia Construction Company has been organized for building an entirely new power plant and distribution system for serving residents of Wilmington. This undertaking, it is understood, is being financed by Baltimore interests. A new plant is now under construction and is designed entirely for steam turbines. Two 750-horse-power Westinghouse-Parsons steam turbines, with a number of motors and generators, will be installed at the present time.

LOCKPORT, N. Y.—The rates for electric power for consumers in the milling district of Lockport have been announced by the Lockport Gas and Electric Company. All consumers of from fifty to 100 horse-power will pay $22 per horse-power per year; 100 to 500 horse-power, $20; 500 to 1,000 horse-power, $19, and all over 1,000 horse-power, $18. These prices are based on the condition that the city of Lockport grants the company the privileges of stringing a high-voltage transmission line along the outskirts of the city to the proposed transmission station in the milling district.

RED BLUFF, CAL.—The Northern California Power Company is doing a large amount of construction work in the vicinity of its power plant at Volta, in the northwestern part of Tehama county, with a view to doubling the capacity of the plant. It has over 100 men at work, and this force will be kept busy until September to complete the work mapped out. When the improvements are finished the plant will be capable of generating 48,000 horse-power. The company is now furnishing power to operate the Chico & Oroville electric road, and has a contract to supply motive power for the San Francisco street car system as soon as it can complete the additions to its plant.

INDUSTRIAL ITEMS.

THE DEAN ELECTRIC COMPANY, Elyria, Ohio, is distributing bulletin No. 103 descriptive and illustrative of portable desk telephones. This will be sent, on request, to any one interested.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., is distributing the July issue of "The Emerson Monthly." This contains timely descriptions of Emerson apparatus and other interesting matter, and also an index to the company's bulletins and price book No. 7.

THE CHARLES J. BOGUE ELECTRIC COMPANY has been incorporated to take over the business formerly conducted by Charles J. Bogue. The officers of the company are: president, Charles J. Bogue; treasurer, L. Robertson; secretary, F. Plante. Headquarters have been established at 213-215 Centre street, New York city.

THE NATIONAL METAL MOULDING COMPANY, Economy, Pa., carries a complete stock of all sizes of mild steel heavy wall conduits in its factory at Economy, and also at its New York warehouse. This conduit is covered inside and outside with enamel, which is claimed to be unaffected by acids or alkalies.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., has issued its first catalogue descriptive of magneto telephones. This catalogue contains sixty-three pages, and gives complete descriptive matter and illustrations bearing on the subject. It is in loose-leaf form, which style has been adopted by the company for future bulletins.

THE NILES-BEMENT-POND COMPANY, 111 Broadway, New York city, has issued list No. 12 of second-hand metal-working machinery. This includes railroad machinery, screw-cutting lathes, speed lathes, chucking machines, planers, shapers, drills, milling and boring machines, grinding and polishing machines, and miscellaneous apparatus.

THE SPRAGUE ELECTRIC COMPANY, New York city, announces that it has reopened its office in San Francisco, Cal. The former office was destroyed by the earthquake, after which temporary quarters were opened in Oakland. The company is now permanently located in the Atlas Building on Mission street, San Francisco, where all orders from that territory will receive prompt attention.

THE UNIVERSAL MANUFACTURING COMPANY, 206-208 Illinois street, Chicago, Ill., has issued a descriptive bulletin of its "Universal" flat-rate controller, which it claims is cheaper than meter service, and which will absolutely control the supply of current to patrons by switching off and on at intervals of thirty seconds whenever the contact load is exceeded by as much as one eight-candle-power lamp.

THE NIAGARA TACHOMETER AND INSTRUMENT COMPANY, Niagara Falls, N. Y., has designed and is now manufacturing a tachometer which is claimed to be of absolute and permanent accuracy, though it has reached the maximum simplicity of construction. The company also manufactures a hand-tachometer. These instruments are manufactured in speed ranges from thirty to 4,000 revolutions per minute.

W. S. BARSTOW & COMPANY, 56 Pine street, New York city, have been engaged as engineers for remodeling the plant of the Jamestown Worsted Mills, Jamestown, N. Y. Plans will be drawn covering an extensive addition to the power plant, and the plant will be changed over to electric-motor drive throughout. Barstow & Company recently completed a similar installation for the Hartford Carpet Corporation, Thompsonville, Ct.

THE WESCO SUPPLY COMPANY, St Louis, Mo., announces that its new general electrical catalogue No. 100 is now completed and is being distributed to the trade. This catalogue is very complete, containing full descriptions of the various appliances. The company will be pleased to send it upon request. The Wesco company is also distributing a net price list in booklet form, covering its line of magneto and central energy telephones, and giving prices on linemen's tools, construction material, exchange equipment and supplies.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., is distributing a series of bulletins dealing with its motor starters and controllers. Bulletin No. 10 illustrates and gives the sizes of multiple switch-starting rheostats; No. 19, of motor-starting rheostats, and No. 17, of motor-starting rheostats of the double-lever type. Bulletin No. 32 gives dimensions for drilling for field rheostats. Bulletin No. 59 deals with radial-arm reversible controllers, describing and giving the dimensions of types A and B. Bulletin No. 70 describes the company's self-starters used for motor-driven pumps, elevators and similar services, and No. 92 lists "Simplicity" type interlocking dimmers.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., reports having closed contracts for the following apparatus: National Tube Company, McKeesport, Pa., twenty-one direct-current motors, ranging from six to seventy-five horse-power. Pensacola Electrical Terminal Railroad Company, Pensacola, Fla., one 500-kilowatt, direct-current generator. American Multigraph Company, Cleveland, Ohio, one 100-kilowatt, alternating-current, engine-type generator, three-phase, sixty cycles, 240 volts, and one six and one-half-horse-power exciter, 125 volts, to be installed at the company's new factory at Cleveland. New Jersey Zinc Company, Franklin Junction, N. J., one seventy-five-horse-power, 115-volt, direct-current motor.

THE STANLEY-G. I. ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has issued bulletin No. 608 and circulars No. 778 and No. 785. The bulletin is devoted to the new "G. I." flush pocket wall receptacle, which is adapted for use with standard Edison attaching plugs and has a round door, eliminating the objectionable sharp corners of the old style of receptacle. Circular No. 778 is entitled "Circuit-Breakers *versus* Switches and Fuses," and gives lists and prices of the Stanley-G. I. "C-7" circuit-breakers. Circular No. 785 describes and illustrates "K-9" arc lamp for multiple alternating-current circuits, which is suitable for operation on standard induction-motor voltages, *viz.:* 220, 440 and 550. Any of this literature will be furnished on request.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has issued a new series of advertising literature, which is now being distributed. Bulletin N. 4441 describes and illustrates type H subway transformers, and supersedes bulletin No. 4400; bulletin No. 4442, the GE-87 railway motor; bulletin No. 4444, direct-current, motor-driven air compressors, geared type; bulletin No. 4445, direct-current Curtis steam turbine-generators, horizontal type, and bulletin No. 4448, small polyphase motors. There are also price lists, No. 5151 and No. 5152, applying, respectively, to National Electrical Code Standard and old code enclosed fuses and cutouts, and to "Gem" regular incandescent units and "Gem" meridian units. Supply catalogue No. 7598 lists parts for plain type carbon feed enclosed arc lamps, and flyers No. 2185 and No. 2190 illustrate and describe, respectively, the "G. E." moulding rosette, and cast-grid field rheostats, type F, form S, for sixty and 125-volt circuits. A four-page folder is devoted to the subject of Edison reflector lamps, and there is a change notice to accompany catalogue No. 1052 on lightning arresters.

THE WESTINGHOUSE MACHINE COMPANY, Pittsburg, Pa., has received an order from the Philadelphia Rapid Transit Company for a complete equipment of Roney mechanical stokers for its large subway power plant now building in Philadelphia. This plant was constructed for turbine machinery, and Westinghouse-Parsons turbines of 6,000-kilowatt capacity will be installed. With the equipment of mechanical stokers and other labor-saving devices the plant will represent one of the most up-to-date modern power stations. The order covers stokers for the entire boiler plant of 32,700 horse-power. The boilers are of the Parker water-tube type. The New York, New Haven & Hartford Railroad Company recently adopted mechanical stokers for its power plant at Cos Cob, Ct., now building to serve the electrified section of the company's New York city terminal. The initial order comprised twelve stokers. These stokers will serve twelve 520-horse-power Babcock & Wilcox water-tube boilers. A large order for mechanical stokers has also been received from the American Steel and Wire Company, Pittsburg, Pa., covering equipments for nineteen boilers.